APPENDIX A

ADEQ FORECAST PRODUCTS FOR GREATER PHOENIX AREA

ADEQ
Arizona Department of Environmental Quality

AIR QUALITY INDEX

VERY UNHEALTHY (201-300)
UNHEALTHY (151-200)
UNHEALTHY FOR SENSITIVE GROUPS (101-150)
MODERATE (51-100)
GOOD (0-50)

AIR QUALITY FORECAST FOR Saturday, June 20, 2015

This report is updated by 1:00 p.m. Sunday thru Friday and is valid for areas within and bordering Maricopa County in Arizona

FORECAST DATE NOTICES (*SEE BELOW FOR DETAILS) AIR POLLUTANT	YESTERDAY Thu 06/18/2015 Ozone Health Watch Highest AQI Reading/Site (*Preliminary data only*)	TODAY Fri 06/19/2015	TOMORROW Sat 06/20/2015	EXTENDED Sun 06/21/2015
O3*	84 North Phoenix & Pinnacle Peak	87 *Moderate*	84 *Moderate*	84 *Moderate*
CO*	8 Greenwood	6 *Good*	5 *Good*	5 *Good*
PM-10*	62 Buckeye	40 *Good*	42 *Good*	40 *Good*
PM-2.5*	43 Durango	52 *Moderate*	51 *Moderate*	47 *Good*

* O3 = Ozone   CO = Carbon Monoxide   PM-10 = Particles 10 microns & smaller   PM-2.5 = Particles smaller than 2.5 microns

*"Ozone Health Watch" means that the highest concentration of OZONE may approach the federal health standard.
"PM-10 or PM-2.5 Health Watch" means that the highest concentration of PM-10 or PM-2.5 may approach the federal health standard.
"High Pollution Advisory" means that the highest concentration of OZONE, PM-10, or PM-2.5 may exceed the federal health standard.
"DUST" means that short periods of high PM-10 concentrations caused by outflow from thunderstorms are possible.

Health Statements	
Friday, 06/19/2015	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
Saturday, 06/20/2015	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.

SYNOPSIS AND DISCUSSION

The high temperature yesterday reached a record matching 115˚F! Similar temperatures will continue through the weekend and into next week. The National Weather Service has an Excessive Heat Warning in effect through Monday. Looking at air quality, there are a few interesting situations to discuss. First of all, ozone continues to be elevated due to the mostly clear skies and less than ideal ventilation. We do not have an Ozone Health Watch issued anymore, but concentrations will continue to approach Health Watch criteria. Secondly, Buckeye PM-10 concentrations were again in the Moderate levels. This is due to unknown local activity and continues to be an outlier compared to the rest of the monitor network. Therefore, I will continue to forecast PM-10 concentrations in the Good range as that is what the rest of the forecast area is expected to be. Lastly, and perhaps most interesting, is PM-2.5. You may have noticed the smoke while driving into work this morning. There are a few little fires around the state; however, the large Lake Fire in Southern California is the primary culprit. Fortunately, the vast majority of the smoke is staying aloft with only a slight increase in PM-2.5 concentrations near the surface. Satellite imagery of the large smoke plume reaching into Arizona makes it look worse than it is. Afternoon heating and winds should create enough dispersion to prevent concentrations from reaching unhealthy levels.

Check back on Sunday for a look ahead at next week's weather and air quality. Until then, have a great weekend! -R.Nicoll

MONITORING SITE MAPS	
INTERACTIVE MAPS	http://alert.fcd.maricopa.gov/alert/Google/v3/air.html http://www.airnow.gov/

POLLUTION MONITOR READINGS FOR Thursday, June 18, 2015

O3 (OZONE)

SITE NAME	MAX 8-HR VALUE (PPB)	MAX AQI	AQI COLOR CODE
Alamo Lake	66	71	
Apache Junction	69	80	
Blue Point	66	71	
Buckeye	51	43	
Casa Grande	60	51	
Cave Creek	64	64	
Central Phoenix	63	61	
Dysart	60	51	
Falcon Field	69	80	
Fountain Hills	63	61	
Glendale	58	49	
Humboldt Mountain	59	50	
Phoenix Supersite	69	80	
Mesa	68	77	
North Phoenix	70	84	
Pinal Air Park	62	58	
Pinnacle Peak	70	84	
Queen Valley	69	80	

Rio Verde	58	49	
South Phoenix	63	61	
South Scottsdale	60	51	
Tempe	NOT AVBL	NOT AVBL	NOT AVBL
Tonto Nat'l Mon.	69	80	
West Chandler	67	74	
West Phoenix	66	71	
Yuma	72	90	

CO (CARBON MONOXIDE)

SITE NAME	MAX 8-HR VALUE (PPM)	MAX AQI	AQI COLOR CODE
Central Phoenix	0.5	6	
Greenwood	0.7	8	
Phoenix Supersite	0.5	6	
West Phoenix	0.5	6	

PM-10 (PARTICLES)

SITE NAME	MAX 24-HR VALUE (µg/m3)	MAX AQI	AQI COLOR CODE
Buckeye	77.4	62	
Central Phoenix	39.7	37	
Combs School (Pinal County)	50.5	47	
Durango	41.2	38	
Dysart	32.4	30	
Glendale	22.4	21	
Greenwood	40.2	37	
Higley	NOT AVBL	NOT AVBL	NOT AVBL
Maricopa (Pinal County)	48.7	45	
Phoenix Supersite	28.6	26	
Mesa	22.9	21	
North Phoenix	25.5	24	
South Phoenix	32.2	30	
South Scottsdale	54.3	50	
Tempe	NOT AVBL	NOT AVBL	NOT AVBL
West Chandler	35.0	32	
West Forty Third	62.1	55	
West Phoenix	22.6	21	
Zuni Hills	25.7	24	

PM-2.5 (PARTICLES)

SITE NAME	MAX 24-HR VALUE (µg/m3)	MAX AQI	AQI COLOR CODE
Diablo	8.2	34	
Durango	10.3	43	
Glendale	6.3	26	
Phoenix Supersite	5.5	23	
Mesa	7.7	32	
North Phoenix	7.3	30	
South Phoenix	7.8	33	
Tempe	NOT AVBL	NOT AVBL	NOT AVBL
West Phoenix	7.0	29	

DESCRIPTION OF LOCAL AIR POLLUTANTS IN DETAIL

O3 (OZONE):

Description –
This is a secondary pollutant that is formed by the reaction of other primary pollutants (precursors) such as VOCs (volatile organic compounds) and NOx (Nitrogen Oxides) in the presence of heat and sunlight.
Sources – VOCs are emitted from motor vehicles, chemical plants, refineries, factories, and other industrial sources. NOx is emitted from motor vehicles, power plants, and other sources of combustion.
Potential health impacts – Exposure to ozone can make people more susceptible to respiratory infection, result in lung inflammation, and aggravate pre-existing respiratory diseases such as asthma. Other effects include decrease in lung function, chest pain, and cough.
Unit of measurement – Parts per billion (ppb).
Averaging interval – Highest eight-hour period within a 24-hour period (midnight to midnight)
Reduction tips – Curtail daytime driving, refuel cars and use gasoline-powered equipment as late in the day as possible.

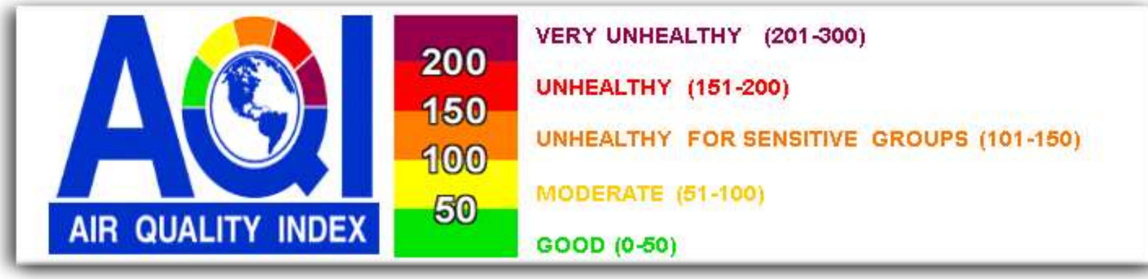
CO (CARBON MONOXIDE):

Description – A colorless, odorless, poisonous gas formed when carbon in fuels is not burned completely.
Sources – In cities, as much as 95 percent of all CO emissions emanate from automobile exhaust. Other sources include industrial processes, non-transportation fuel combustion, and natural sources such as wildfires. Peak concentrations occur in colder winter months.
Potential health impacts – Reduces oxygen delivery to the body's organs and tissues. The health threat is most serious for those who suffer from cardiovascular disease.
Unit of measurement – Parts per million (ppm).
Averaging interval – Highest eight-hour period within a 24-hour period (midnight to midnight)
Reduction tips – Keep motor vehicle tuned properly and minimize nighttime driving.

PM-10 & PM-2.5 (PARTICLES):

Description – The term "particulate matter" (PM) includes both solid particles and liquid droplets found in air. Many manmade and natural sources emit PM directly or emit other pollutants that react in the atmosphere to form PM. Particles less than 10 micrometers in diameter tend to pose the greatest health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter are referred to as "fine" particles and are responsible for many visibility degradations such as the "Valley Brown Cloud" (see http://www.phoenixvis.net/). Particles with diameters between 2.5 and 10 micrometers are referred to as "coarse".
Sources – Fine = All types of combustion (motor vehicles, power plants, wood burning, etc.) and some industrial processes. Coarse = crushing or grinding operations and dust from paved or unpaved roads.
Potential health impacts – PM can increase susceptibility to respiratory infections and can aggravate existing respiratory diseases, such as asthma and chronic bronchitis.
Units of measurement – Micrograms per cubic meter (ug/m3)
Averaging interval – 24 hours (midnight to midnight).
Reduction tips – Stabilize loose soils, slow down on dirt roads, carpool, and use public transit.

{**Updated 12/19/2011**}



AIR QUALITY FORECAST FOR Monday, June 22, 2015

This report is updated by 1:00 p.m. Sunday thru Friday and is valid for areas within and bordering Maricopa County in Arizona

FORECAST DATE NOTICES (*SEE BELOW FOR DETAILS) AIR POLLUTANT	YESTERDAY Sat 06/20/2015 Highest AQI Reading/Site (*Preliminary data only*)	TODAY Sun 06/21/2015 Same Day Ozone Health Watch	TOMORROW Mon 06/22/2015 Ozone Health Watch	EXTENDED Tue 06/23/2015
O3*	**111 Falcon Field**	**98 *Moderate***	**92 *Moderate***	**88 *Moderate***
CO*	**8 Greenwood**	**5 *Good***	**6 *Good***	**5 *Good***
PM-10*	**51 Buckeye**	**40 *Good***	**42 *Good***	**46 *Good***
PM-2.5*	**33 South Phoenix**	**47 *Good***	**34 *Good***	**38 *Good***

* O3 = Ozone CO = Carbon Monoxide PM-10 = Particles 10 microns & smaller PM-2.5 = Particles smaller than 2.5 microns

*"Ozone Health Watch" means that the highest concentration of OZONE may approach the federal health standard.

"PM-10 or PM-2.5 Health Watch" means that the highest concentration of PM-10 or PM-2.5 may approach the federal health standard.

"High Pollution Advisory" means that the highest concentration of OZONE, PM-10, or PM-2.5 may exceed the federal health standard.

"DUST" means that short periods of high PM-10 concentrations caused by outflow from thunderstorms are possible.

Health Statements	
Sunday, 06/21/2015	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
Monday, 06/22/2015	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.

SYNOPSIS AND DISCUSSION

Several monitors in the eastern part of the Valley reported an ozone exceedance. This pool of ozone originally began near the southwestern part of the state and moved eastward through Yuma. Lake Fire in Southern California burned through quite a lot of vegetation and released vast amounts of VOCs into the atmosphere. This is a major precursor of ozone. Thus, Yuma reported very high concentrations of this pollutant on Friday and around 24 hours later, it hit the Valley.

Looking ahead, it seems like ozone will likely be an issue for the next couple of days. Therefore, a same day Ozone Health Watch is warranted. The high pressure system overhead will continue its influence over the Southwest. Surface winds are expected to be fairly breezy with hot temperatures during the day. The atmosphere overhead is very dry, and it will continue to remain this way for the next couple of days. Once this surface high moves eastward, a moisture surge from the Gulf of Mexico will take place. This mid-level moisture surge has a strong potential to bring us our first monsoonal rains. However, it will probably occur towards the end of this work week. So, in the meantime, expect very hot temperatures with elevated ozone and low PM-10 concentrations.

Check back tomorrow for more. Until then, have a good day! -P.Patel

MONITORING SITE MAPS	
INTERACTIVE MAPS	http://alert.fcd.maricopa.gov/alert/Google/v3/air.html http://www.airnow.gov/

POLLUTION MONITOR READINGS FOR Saturday, June 20, 2015

O3 (OZONE)

SITE NAME	MAX 8-HR VALUE (PPB)	MAX AQI	AQI COLOR CODE
Alamo Lake	60	51	
Apache Junction	78	106	
Blue Point	77	104	
Buckeye	54	46	
Casa Grande	63	61	
Cave Creek	69	80	
Central Phoenix	68	77	
Dysart	62	58	
Falcon Field	80	111	
Fountain Hills	73	93	
Glendale	64	64	
Humboldt Mountain	73	93	
Phoenix Supersite	68	77	
Mesa	79	109	
North Phoenix	73	93	
Pinal Air Park	61	54	
Pinnacle Peak	78	106	
Queen Valley	73	93	
Rio Verde	65	67	
South Phoenix	67	74	
South Scottsdale	70	84	

Tempe	NOT AVBL	NOT AVBL	NOT AVBL
Tonto Nat'l Mon.	79	109	
West Chandler	69	80	
West Phoenix	67	74	
Yuma	43	36	

CO (CARBON MONOXIDE)

SITE NAME	MAX 8-HR VALUE (PPM)	MAX AQI	AQI COLOR CODE
Central Phoenix	0.4	5	
Greenwood	0.7	8	
Phoenix Supersite	0.5	6	
West Phoenix	0.5	6	

PM-10 (PARTICLES)

SITE NAME	MAX 24-HR VALUE (µg/m3)	MAX AQI	AQI COLOR CODE
Buckeye	54.9	51	
Central Phoenix	34.1	32	
Combs School (Pinal County)	44.4	41	
Durango	23.0	21	
Dysart	27.5	25	
Glendale	22.5	21	
Greenwood	34.8	32	
Higley	NOT AVBL	NOT AVBL	NOT AVBL
Maricopa (Pinal County)	65.3	56	
Phoenix Supersite	29.5	27	
Mesa	18.8	17	
North Phoenix	25.3	23	
South Phoenix	27.4	25	
South Scottsdale	34.1	32	
Tempe	NOT AVBL	NOT AVBL	NOT AVBL
West Chandler	31.2	29	
West Forty Third	40.1	37	
West Phoenix	27.5	25	
Zuni Hills	27.0	25	

PM-2.5 (PARTICLES)

SITE NAME	MAX 24-HR VALUE (µg/m3)	MAX AQI	AQI COLOR CODE
Diablo	7.7	32	
Durango	7.7	32	
Glendale	7.0	29	
Phoenix Supersite	6.3	26	
Mesa	7.0	29	
North Phoenix	7.2	30	
South Phoenix	7.9	33	
Tempe	NOT AVBL	NOT AVBL	NOT AVBL
West Phoenix	7.6	32	

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Potential health impacts – Reduces oxygen delivery to the body's organs and tissues. The health threat is most serious for those who suffer from cardiovascular disease.
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PM-10 & PM-2.5 (PARTICLES):

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Units of measurement – Micrograms per cubic meter (ug/m3)
Averaging interval – 24 hours (midnight to midnight).
Reduction tips – Stabilize loose soils, slow down on dirt roads, carpool, and use public transit.

{**Updated 12/19/2011**}

APPENDIX B

NWS METEOROLOGICAL OBSERVATIONS AT PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA
(final)
HOURLY OBSERVATIONS TABLE
PHOENIX SKY HARBOR INTL AIRPORT (23183)
PHOENIX, AZ
(06/2015)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Elevation: 1107 ft. above sea level
Latitude: 33.427
Longitude: -112.003
Data Version: VER3

Date	Time (LST)	Station Type	Sky Conditions	Visibility (SM)	Weather Type	Dry Bulb Temp (F)	Dry Bulb Temp (C)	Wet Bulb Temp (F)	Wet Bulb Temp (C)	Dew Point Temp (F)	Dew Point Temp (C)	Rel Humd %	Wind Speed (MPH)	Wind Dir	Wind Gusts (MPH)	Station Pressure (in. hg)	Press Tend	Net 3-hr Chg (mb)	Sea Level Pressure (in. hg)	Report Type	Precip. Total (in)	Alti-meter (in. hg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
17	0051	11	CLR	10.00		98	36.7	65	18.4	42	5.6	15	15	270		28.60			29.70	AA		29.77
17	0151	11	CLR	10.00		92	33.3	64	17.7	44	6.7	19	7	250		28.61			29.71	AA		29.78
17	0251	11	CLR	10.00		91	32.8	64	17.5	44	6.7	20	0	000		28.62			29.72	AA		29.79
17	0351	11	CLR	10.00		90	32.2	64	17.8	46	7.8	22	5	140		28.63			29.73	AA		29.80
17	0451	11	FEW130	10.00		90	32.2	64	17.6	45	7.2	21	0	000		28.63			29.72	AA		29.80
17	0551	11	FEW150	10.00		86	30.0	64	18.0	50	10.0	29	9	090		28.64			29.75	AA		29.81
17	0651	11	CLR	10.00		88	31.1	64	17.9	48	8.9	25	8	110		28.66			29.76	AA		29.83
17	0751	11	FEW180	10.00		93	33.9	65	18.3	46	7.8	20	8	120		28.68			29.78	AA		29.85
17	0851	11	FEW180	10.00		98	36.7	67	19.2	46	7.8	17	5	150		28.68			29.78	AA		29.85
17	0951	11	FEW180	10.00		100	37.8	67	19.3	45	7.2	15	9	090		28.68			29.78	AA		29.85
17	1051	11	FEW120	10.00		103	39.4	68	20.0	46	7.8	14	7	140		28.68			29.78	AA		29.85
17	1151	11	FEW120	10.00		107	41.7	69	20.5	45	7.2	12	7	VR		28.66			29.76	AA		29.83
17	1251	11	FEW120	10.00		110	43.3	68	20.0	39	3.9	9	0	000		28.64			29.74	AA		29.81
17	1351	11	FEW120	10.00		111	43.9	67	19.2	32	0.0	6	11	330		28.62			29.72	AA		29.79
17	1451	11	FEW120 FEW250	10.00		112	44.4	67	19.4	33	0.6	7	10	270		28.59			29.68	AA		29.76
17	1551	11	FEW120 FEW250	10.00		113	45.0	68	19.9	35	1.7	7	16	270	24	28.56			29.66	AA		29.73
17	1651	11	FEW120 FEW250	10.00		112	44.4	68	19.8	36	2.2	7	11	270	21	28.54			29.64	AA		29.71
17	1751	11	FEW120 FEW250	10.00		111	43.9	67	19.5	35	1.7	7	16	280		28.53			29.62	AA		29.70
17	1851	11	FEW120 SCT250	10.00		111	43.9	67	19.5	35	1.7	7	16	260		28.53			29.63	AA		29.70
17	1951	11	FEW120 SCT210 BKN250	10.00		107	41.7	67	19.1	37	2.8	9	13	260		28.54			29.63	AA		29.71
17	2051	11	FEW120 FEW210 BKN250	10.00		104	40.0	66	18.9	39	3.9	11	6	250		28.56			29.65	AA		29.73
17	2151	11	FEW250	10.00		105	40.6	66	18.9	38	3.3	10	9	290		28.58			29.67	AA		29.75
17	2251	11	CLR	10.00		104	40.0	66	18.6	37	2.8	10	13	290		28.58			29.67	AA		29.75
17	2351	11	CLR	10.00		98	36.7	65	18.0	40	4.4	13	9	260		28.58			29.68	AA		29.75

Dynamically generated Wed May 25 12:46:37 EDT 2016 via http://www.ncdc.noaa.gov/qclcd/QCLCD

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA (final)
HOURLY OBSERVATIONS TABLE
PHOENIX SKY HARBOR INTL AIRPORT (23183)
PHOENIX, AZ
(06/2015)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Elevation: 1107 ft. above sea level
Latitude: 33.427
Longitude: -112.003
Data Version: VER3

Date	Time (LST)	Station Type	Sky Conditions	Visibility (SM)	Weather Type	Dry Bulb Temp (F)	Dry Bulb Temp (C)	Wet Bulb Temp (F)	Wet Bulb Temp (C)	Dew Point Temp (F)	Dew Point Temp (C)	Rel Humd %	Wind Speed (MPH)	Wind Dir	Wind Gusts (MPH)	Station Pressure (in. hg)	Press Tend	Net 3-hr Chg (mb)	Sea Level Pressure (in. hg)	Report Type	Precip. Total (in)	Alti-meter (in. hg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
18	0051	11	CLR	10.00		99	37.2	65	18.0	39	3.9	12	9	310		28.59			29.68	AA		29.76
18	0151	11	CLR	10.00		97	36.1	64	17.9	40	4.4	14	9	320		28.59			29.68	AA		29.76
18	0251	11	CLR	10.00		96	35.6	63	17.3	38	3.3	13	6	270		28.59			29.69	AA		29.76
18	0351	11	CLR	10.00		89	31.7	63	17.2	44	6.7	21	3	250		28.60			29.70	AA		29.77
18	0451	11	FEW150	10.00		88	31.1	63	17.2	45	7.2	22	5	110		28.61			29.71	AA		29.78
18	0551	11	CLR	10.00		88	31.1	62	16.6	42	5.6	20	6	090		28.64			29.74	AA		29.81
18	0651	11	CLR	10.00		90	32.2	63	16.9	42	5.6	19	8	080		28.66			29.76	AA		29.83
18	0751	11	CLR	10.00		93	33.9	64	17.7	43	6.1	18	5	100		28.66			29.77	AA		29.84
18	0851	11	CLR	10.00		98	36.7	65	18.2	41	5.0	14	3	VR		28.68			29.78	AA		29.85
18	0951	11	CLR	10.00		102	38.9	66	18.9	41	5.0	12	5	100		28.68			29.77	AA		29.85
18	1051	11	CLR	10.00		106	41.1	67	19.3	39	3.9	10	0	000		28.68			29.77	AA		29.85
18	1151	11	CLR	10.00		109	42.8	67	19.3	36	2.2	8	3	VR		28.66			29.75	AA		29.83
18	1251	11	FEW120	10.00		112	44.4	67	19.6	34	1.1	7	5	270		28.64			29.73	AA		29.81
18	1351	11	FEW120	10.00		111	43.9	67	19.3	33	0.6	7	6	260	20	28.61			29.70	AA		29.78
18	1451	11	FEW120	10.00		114	45.6	68	19.8	33	0.6	6	13	280	18	28.58			29.68	AA		29.75
18	1551	11	FEW120	10.00		114	45.6	67	19.7	32	0.0	6	13	240	21	28.56			29.66	AA		29.73
18	1651	11	FEW120 FEW210	10.00		114	45.6	68	19.8	33	0.6	6	14	250	21	28.54			29.64	AA		29.71
18	1751	11	FEW210	10.00		113	45.0	67	19.6	33	0.6	6	16	260	22	28.53			29.62	AA		29.70
18	1851	11	SCT210	10.00		110	43.3	67	19.5	36	2.2	8	13	240		28.53			29.63	AA		29.70
18	1951	11	SCT110 BKN210 BKN250	10.00		108	42.2	67	19.1	36	2.2	8	9	250		28.54			29.64	AA		29.71
18	2051	11	SCT110 SCT210 BKN250	10.00		103	39.4	65	18.3	36	2.2	10	9	230		28.56			29.66	AA		29.73
18	2151	11	FEW250	10.00		101	38.3	64	17.5	33	0.6	9	8	250		28.58			29.67	AA		29.75
18	2251	11	FEW250	10.00		100	37.8	63	17.0	31	-0.6	9	7	270		28.58			29.68	AA		29.75
18	2351	11	FEW250	10.00		99	37.2	63	16.9	32	0.0	9	9	270		28.58			29.68	AA		29.75

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U.S. Department of Commerce
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QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA
(final)
HOURLY OBSERVATIONS TABLE
PHOENIX SKY HARBOR INTL AIRPORT (23183)
PHOENIX, AZ
(06/2015)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Elevation: 1107 ft. above sea level
Latitude: 33.427
Longitude: -112.003
Data Version: VER3

Date	Time (LST)	Station Type	Sky Conditions	Visibility (SM)	Weather Type	Dry Bulb Temp (F)	Dry Bulb Temp (C)	Wet Bulb Temp (F)	Wet Bulb Temp (C)	Dew Point Temp (F)	Dew Point Temp (C)	Rel Humd %	Wind Speed (MPH)	Wind Dir	Wind Gusts (MPH)	Station Pressure (in. hg)	Press Tend	Net 3-hr Chg (mb)	Sea Level Pressure (in. hg)	Report Type	Precip. Total (in)	Alti-meter (in. hg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
19	0051	11	FEW250	10.00		96	35.6	63	17.0	36	2.2	12	0	000		28.57			29.67	AA		29.74
19	0151	11	CLR	10.00		97	36.1	63	17.2	36	2.2	12	7	340		28.57			29.67	AA		29.74
19	0251	11	CLR	10.00		94	34.4	62	16.4	35	1.7	12	0	000		28.57			29.67	AA		29.74
19	0351	11	CLR	10.00		90	32.2	62	16.4	39	3.9	17	0	000		28.58			29.68	AA		29.75
19	0451	11	SCT250	10.00		87	30.6	62	16.6	43	6.1	21	3	180		28.59			29.70	AA		29.76
19	0551	11	SCT110 BKN200 BKN250	10.00		86	30.0	63	17.2	47	8.3	26	5	110		28.61			29.71	AA		29.78
19	0651	11	BKN220 BKN250	10.00		88	31.1	63	17.0	44	6.7	22	8	110		28.62			29.72	AA		29.79
19	0751	11	BKN220 BKN250	10.00		92	33.3	64	17.9	45	7.2	20	8	090		28.63			29.73	AA		29.80
19	0851	11	BKN250	10.00		97	36.1	65	18.4	43	6.1	16	8	100		28.64			29.74	AA		29.81
19	0951	11	BKN250	10.00		101	38.3	67	19.3	44	6.7	14	9	160	21	28.64			29.73	AA		29.81
19	1051	11	BKN250	10.00		105	40.6	65	18.5	35	1.7	9	7	120		28.63			29.72	AA		29.80
19	1151	11	BKN250	10.00		107	41.7	65	18.4	32	0.0	7	3	VR		28.61			29.71	AA		29.78
19	1251	11	BKN250	10.00		109	42.8	66	18.9	33	0.6	7	0	000		28.59			29.69	AA		29.76
19	1351	11	BKN250	10.00		111	43.9	65	18.5	26	-3.3	5	11	230	17	28.57			29.67	AA		29.74
19	1451	11	FEW210 BKN250	10.00		114	45.6	66	18.8	24	-4.4	4	18	270	28	28.56			29.65	AA		29.73
19	1528	11	CLR	10.00		112	44.4	65	18.1	20	-6.7	4	15	260		28.55			M	SP		29.72
19	1551	11	FEW210 BKN250	10.00		112	44.4	64	17.9	16	-8.9	3	11	250		28.54			29.63	AA		29.71
19	1651	11	FEW210 SCT250	10.00		111	43.9	64	17.5	13	-10.6	3	14	230	22	28.52			29.62	AA		29.69
19	1751	11	FEW210 SCT250	10.00		110	43.3	63	17.1	10	-12.2	3	13	270	20	28.51			29.61	AA		29.68
19	1851	11	CLR	10.00		109	42.8	62	16.8	5	-15.0	2	13	280		28.51			29.61	AA		29.68
19	1951	11	FEW250	10.00		105	40.6	61	16.0	7	-13.9	3	8	250		28.52			29.62	AA		29.69
19	2051	11	FEW250	10.00		100	37.8	59	15.0	9	-12.8	3	6	230		28.53			29.63	AA		29.70
19	2151	11	FEW250	10.00		98	36.7	58	14.6	10	-12.2	4	0	000		28.55			29.65	AA		29.72
19	2251	11	CLR	10.00		100	37.8	59	14.8	6	-14.4	3	0	000		28.56			29.65	AA		29.73
19	2351	11	CLR	10.00		90	32.2	58	14.6	28	-2.2	11	8	090		28.55			29.65	AA		29.72

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(23183)
PHOENIX, AZ
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National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Elevation: 1107 ft. above sea level
Latitude: 33.427
Longitude: -112.003
Data Version: VER3

Date	Time (LST)	Station Type	Sky Conditions	Visibility (SM)	Weather Type	Dry Bulb Temp (F)	Dry Bulb Temp (C)	Wet Bulb Temp (F)	Wet Bulb Temp (C)	Dew Point Temp (F)	Dew Point Temp (C)	Rel Humd %	Wind Speed (MPH)	Wind Dir	Wind Gusts (MPH)	Station Pressure (in. hg)	Press Tend	Net 3-hr Chg (mb)	Sea Level Pressure (in. hg)	Report Type	Precip. Total (in)	Alti-meter (in. hg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
20	0051	11	CLR	10.00		88	31.1	58	14.4	30	-1.1	12	5	090		28.55			29.65	AA		29.72
20	0151	11	CLR	10.00		85	29.4	57	14.1	32	0.0	15	5	120		28.55			29.65	AA		29.72
20	0251	11	CLR	10.00		85	29.4	58	14.1	32	0.0	15	3	110		28.56			29.66	AA		29.73
20	0351	11	CLR	10.00		82	27.8	55	12.6	26	-3.3	13	3	VR		28.57			29.67	AA		29.74
20	0451	11	CLR	10.00		82	27.8	56	13.2	30	-1.1	15	3	130		28.59			29.69	AA		29.76
20	0551	11	FEW210	10.00		81	27.2	55	12.9	30	-1.1	16	6	100		28.61			29.71	AA		29.78
20	0651	11	CLR	10.00		84	28.9	57	13.6	30	-1.1	14	11	110		28.62			29.72	AA		29.79
20	0751	11	CLR	10.00		89	31.7	58	14.7	30	-1.1	12	8	110		28.65			29.75	AA		29.82
20	0851	11	CLR	10.00		92	33.3	59	15.0	28	-2.2	10	6	110		28.66			29.76	AA		29.83
20	0951	11	CLR	10.00		98	36.7	61	16.2	28	-2.2	8	5	VR		28.66			29.76	AA		29.83
20	1051	11	CLR	10.00		102	38.9	63	17.0	28	-2.2	7	6	VR		28.66			29.75	AA		29.83
20	1151	11	CLR	10.00		104	40.0	63	17.2	26	-3.3	6	7	320		28.65			29.75	AA		29.82
20	1251	11	CLR	10.00		107	41.7	64	18.0	28	-2.2	6	6	VR		28.63			29.73	AA		29.80
20	1351	11	CLR	10.00		108	42.2	65	18.0	27	-2.8	6	8	240		28.60			29.70	AA		29.77
20	1451	11	CLR	10.00		111	43.9	65	18.3	24	-4.4	5	13	290		28.58			29.69	AA		29.75
20	1551	11	CLR	10.00		110	43.3	64	17.7	20	-6.7	4	6	280		28.56			29.66	AA		29.73
20	1651	11	CLR	10.00		111	43.9	65	18.2	23	-5.0	4	5	VR		28.53			29.63	AA		29.70
20	1751	11	CLR	10.00		111	43.9	64	17.9	20	-6.7	4	10	300		28.52			29.62	AA		29.69
20	1851	11	CLR	10.00		109	42.8	64	17.7	22	-5.6	5	8	280		28.53			29.63	AA		29.70
20	1951	11	CLR	10.00		107	41.7	63	17.1	20	-6.7	4	5	260		28.53			29.63	AA		29.70
20	2051	11	CLR	10.00		102	38.9	62	16.7	26	-3.3	7	3	220		28.53			29.64	AA		29.70
20	2151	11	CLR	10.00		100	37.8	63	17.3	33	0.6	10	5	250		28.54			29.64	AA		29.71
20	2251	11	CLR	10.00		97	36.1	63	17.3	37	2.8	12	6	240		28.56			29.66	AA		29.73
20	2351	11	CLR	10.00		97	36.1	65	18.0	41	5.0	14	8	270		28.57			29.67	AA		29.74

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U.S. Department of Commerce
National Oceanic & Atmospheric Administration

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(final)
HOURLY OBSERVATIONS TABLE
PHOENIX SKY HARBOR INTL AIRPORT
(23183)
PHOENIX, AZ
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Elevation: 1107 ft. above sea level
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Data Version: VER3

Date	Time (LST)	Station Type	Sky Conditions	Visibility (SM)	Weather Type	Dry Bulb Temp		Wet Bulb Temp		Dew Point Temp		Rel Humd %	Wind Speed (MPH)	Wind Dir	Wind Gusts (MPH)	Station Pressure (in. hg)	Press Tend	Net 3-hr Chg (mb)	Sea Level Pressure (in. hg)	Report Type	Precip. Total (in)	Alti-meter (in. hg)
						(F)	(C)	(F)	(C)	(F)	(C)											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
21	0051	11	CLR	10.00		96	35.6	66	18.8	46	7.8	18	7	330		28.59			29.68	AA		29.76
21	0151	11	CLR	10.00		94	34.4	69	20.3	54	12.2	26	10	320		28.60			29.70	AA		29.77
21	0251	11	CLR	10.00		91	32.8	69	20.3	56	13.3	31	5	160		28.62			29.72	AA		29.79
21	0351	11	CLR	10.00		89	31.7	66	18.7	51	10.6	27	10	150		28.65			29.75	AA		29.82
21	0451	11	CLR	10.00		89	31.7	67	19.2	53	11.7	29	5	020		28.66			29.76	AA		29.83
21	0551	11	CLR	10.00		88	31.1	67	19.6	55	12.8	33	7	280		28.69			29.80	AA		29.87
21	0651	11	CLR	10.00		89	31.7	67	19.2	53	11.7	29	9	300		28.71			29.82	AA		29.89
21	0751	11	CLR	10.00		90	32.2	67	19.2	52	11.1	27	6	300		28.73			29.84	AA		29.91
21	0851	11	CLR	10.00		92	33.3	67	19.5	52	11.1	26	0	000		28.74			29.85	AA		29.92
21	0951	11	CLR	10.00		94	34.4	68	19.9	52	11.1	24	0	000		28.73			29.85	AA		29.91
21	1051	11	CLR	10.00		97	36.1	69	20.6	53	11.7	23	7	010		28.73			29.84	AA		29.91
21	1151	11	CLR	10.00		100	37.8	70	20.8	52	11.1	20	3	VR		28.71			29.82	AA		29.89
21	1251	11	CLR	10.00		102	38.9	69	20.7	50	10.0	17	0	000		28.69			29.79	AA		29.86
21	1351	11	CLR	10.00		104	40.0	70	20.8	49	9.4	16	6	240		28.66			29.77	AA		29.84
21	1451	11	CLR	10.00		107	41.7	71	21.5	50	10.0	15	6	270		28.64			29.74	AA		29.81
21	1551	11	CLR	10.00		107	41.7	71	21.5	50	10.0	15	11	250		28.62			29.72	AA		29.79
21	1651	11	CLR	10.00		107	41.7	70	21.3	49	9.4	14	9	250		28.61			29.71	AA		29.78
21	1751	11	CLR	10.00		107	41.7	69	20.7	46	7.8	13	7	300		28.59			29.69	AA		29.76
21	1851	11	CLR	10.00		107	41.7	68	20.1	43	6.1	11	10	280		28.59			29.69	AA		29.76
21	1951	11	CLR	10.00		105	40.6	68	20.2	45	7.2	13	11	290		28.58			29.68	AA		29.75
21	2051	11	CLR	10.00		102	38.9	67	19.5	44	6.7	14	7	240		28.60			29.70	AA		29.77
21	2151	11	CLR	10.00		98	36.7	67	19.2	46	7.8	17	5	230		28.62			29.72	AA		29.79
21	2251	11	CLR	10.00		98	36.7	66	19.0	45	7.2	16	8	260		28.62			29.72	AA		29.79
21	2351	11	CLR	10.00		96	35.6	68	19.7	50	10.0	21	9	270		28.63			29.73	AA		29.80

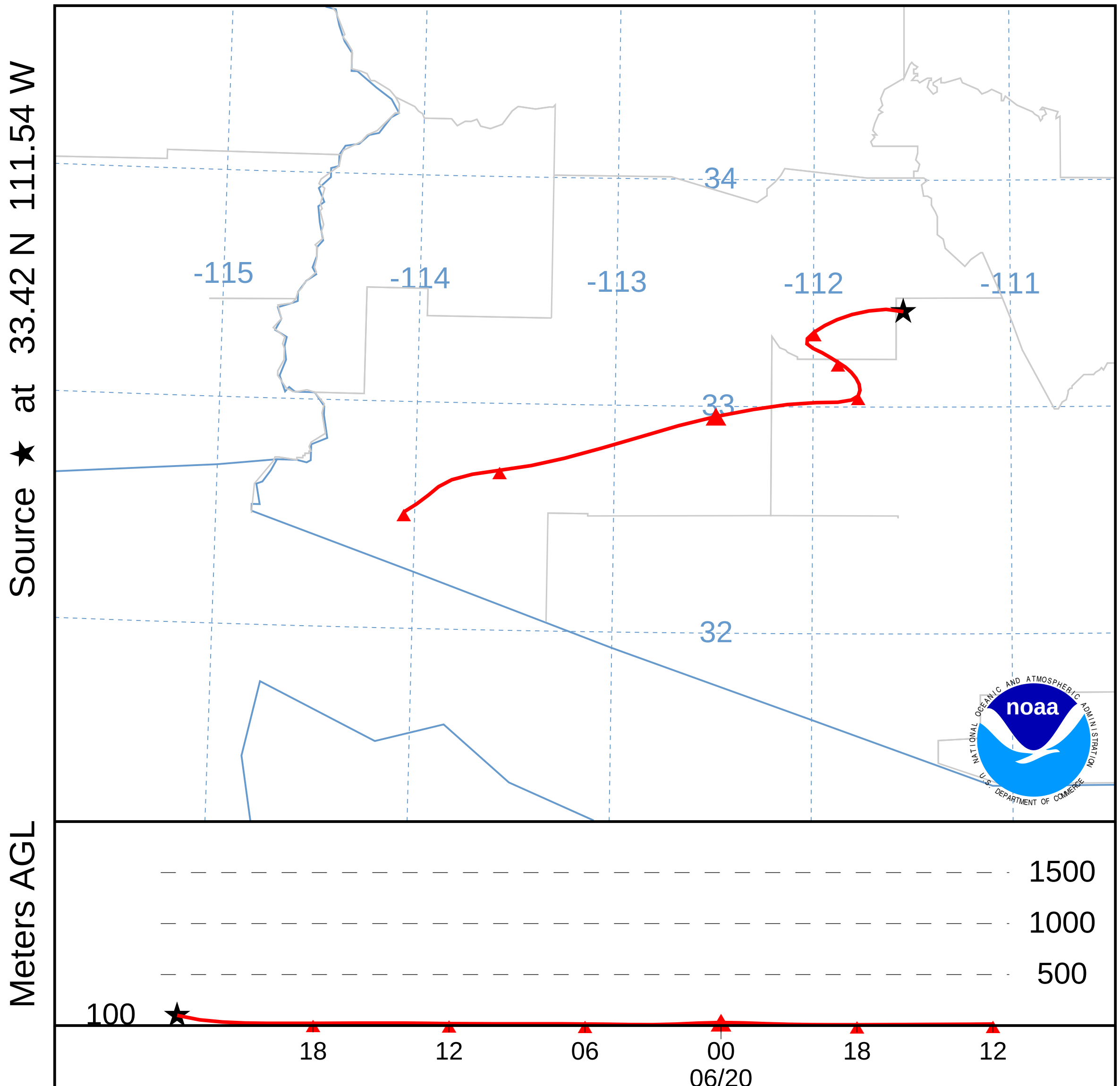
Dynamically generated Wed May 25 12:48:58 EDT 2016 via http://www.ncdc.noaa.gov/qclcd/QCLCD

APPENDIX C

NOAA HYSPLIT MODEL OUTPUT FILES

Apache Junction - 100 meters

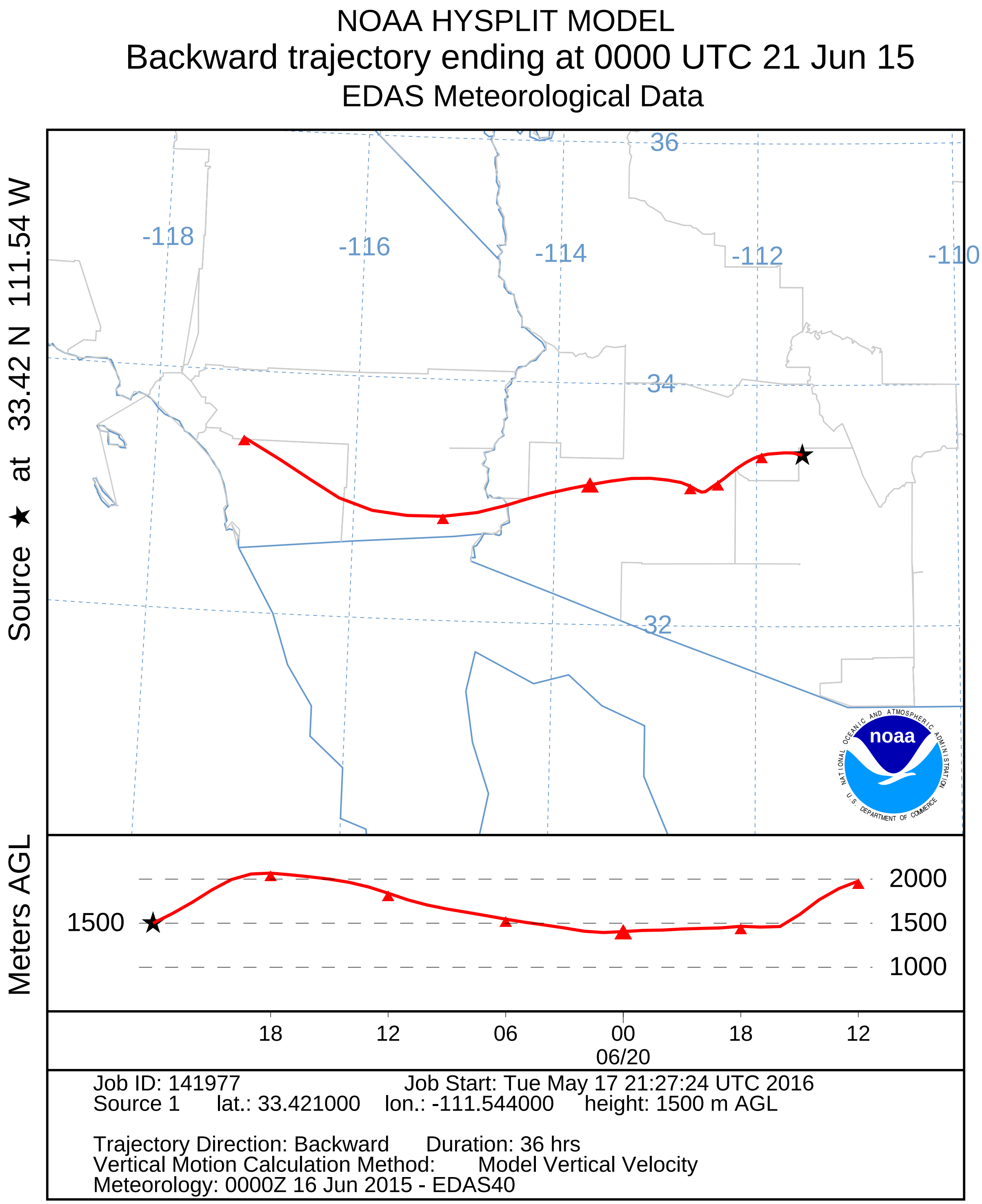
NOAA HYSPLIT MODEL
Backward trajectory ending at 0000 UTC 21 Jun 15
EDAS Meteorological Data



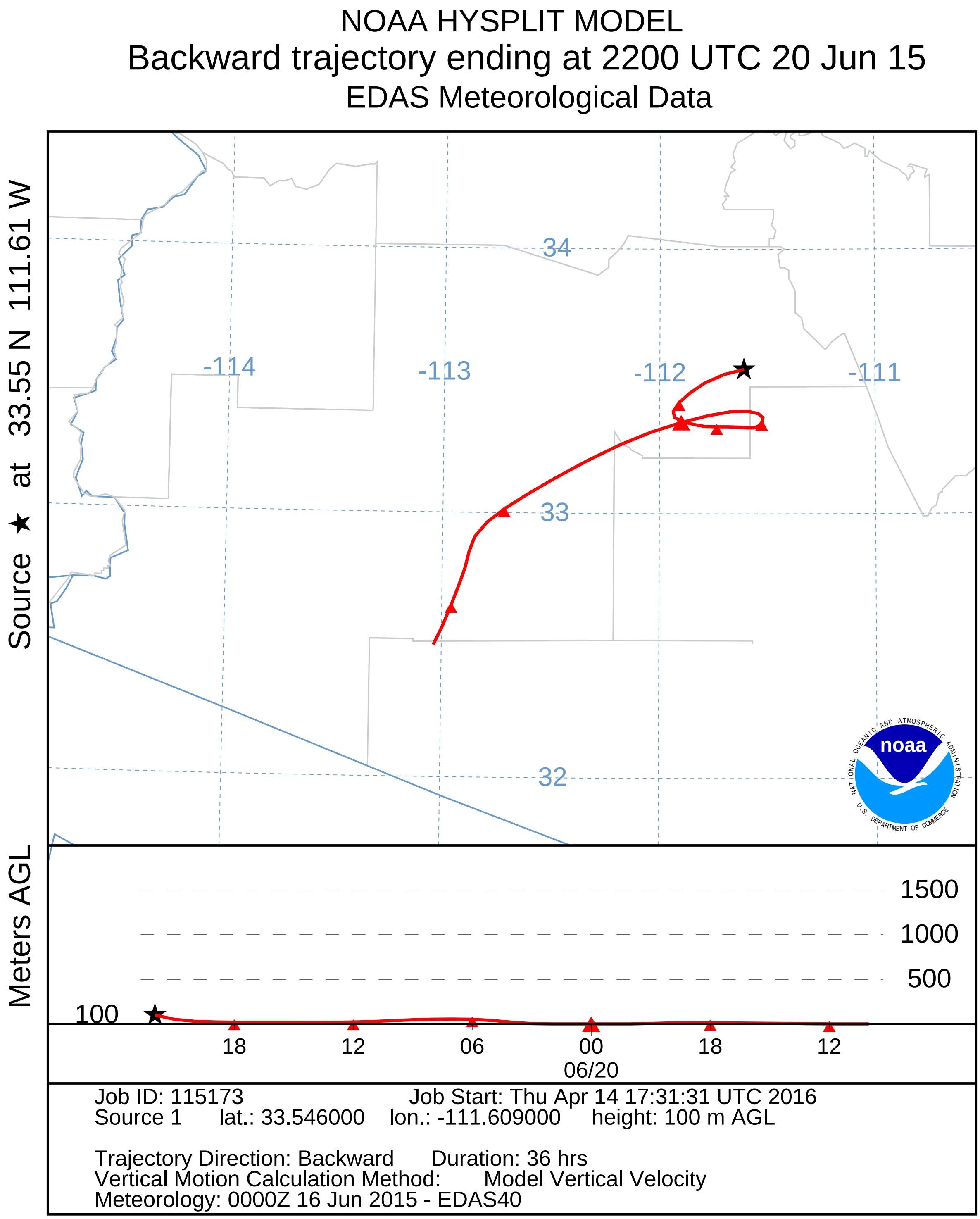
Job ID: 115394 Job Start: Thu Apr 14 17:47:46 UTC 2016
Source 1 lat.: 33.421000 lon.: -111.544000 height: 100 m AGL

Trajectory Direction: Backward Duration: 36 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 16 Jun 2015 - EDAS40

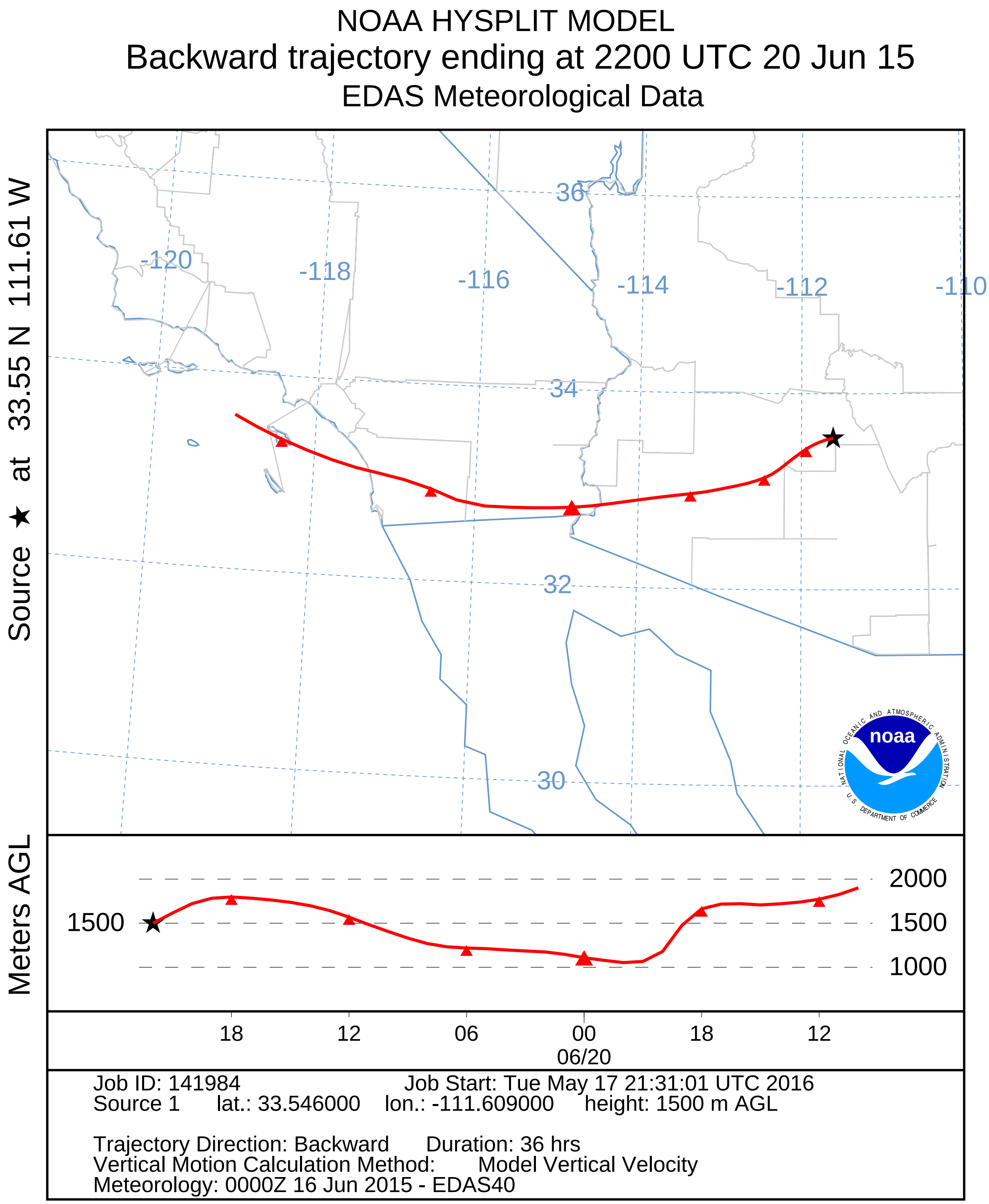
Apache Junction - 1500 meters



Blue Point - 100 meters



Blue Point - 1500 meters

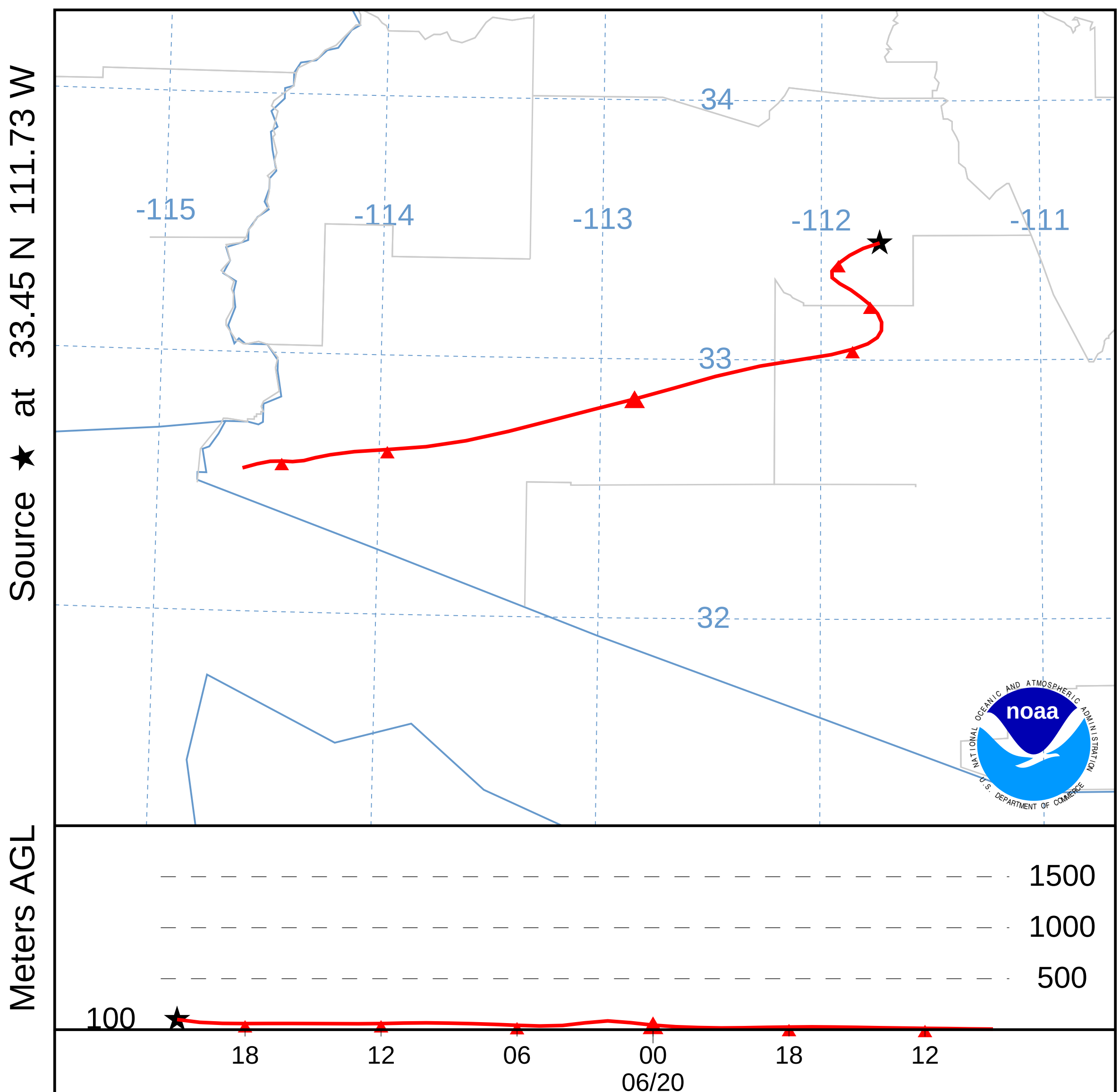


Falcon Field - 100 meters

NOAA HYSPLIT MODEL

Backward trajectory ending at 2100 UTC 20 Jun 15

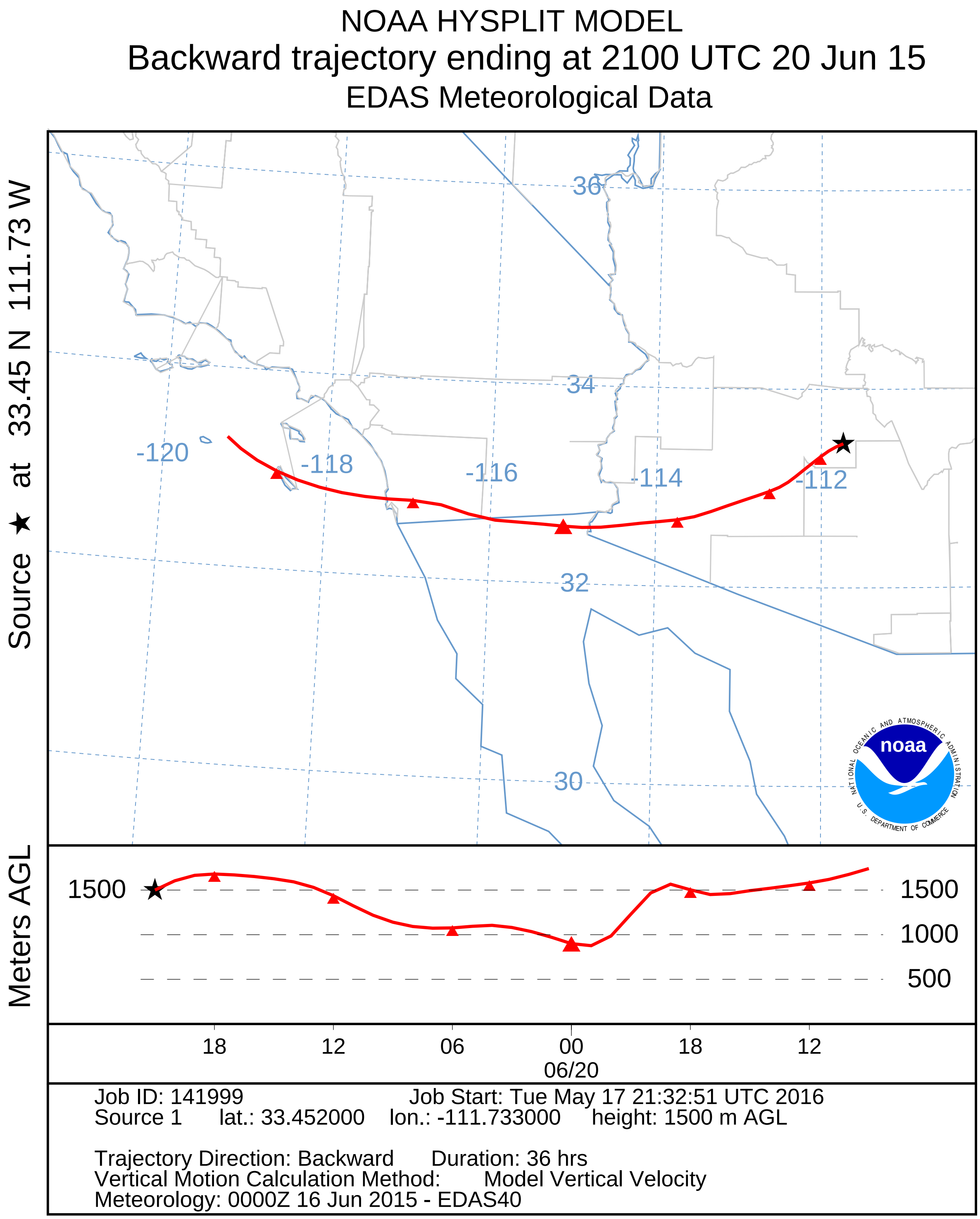
EDAS Meteorological Data



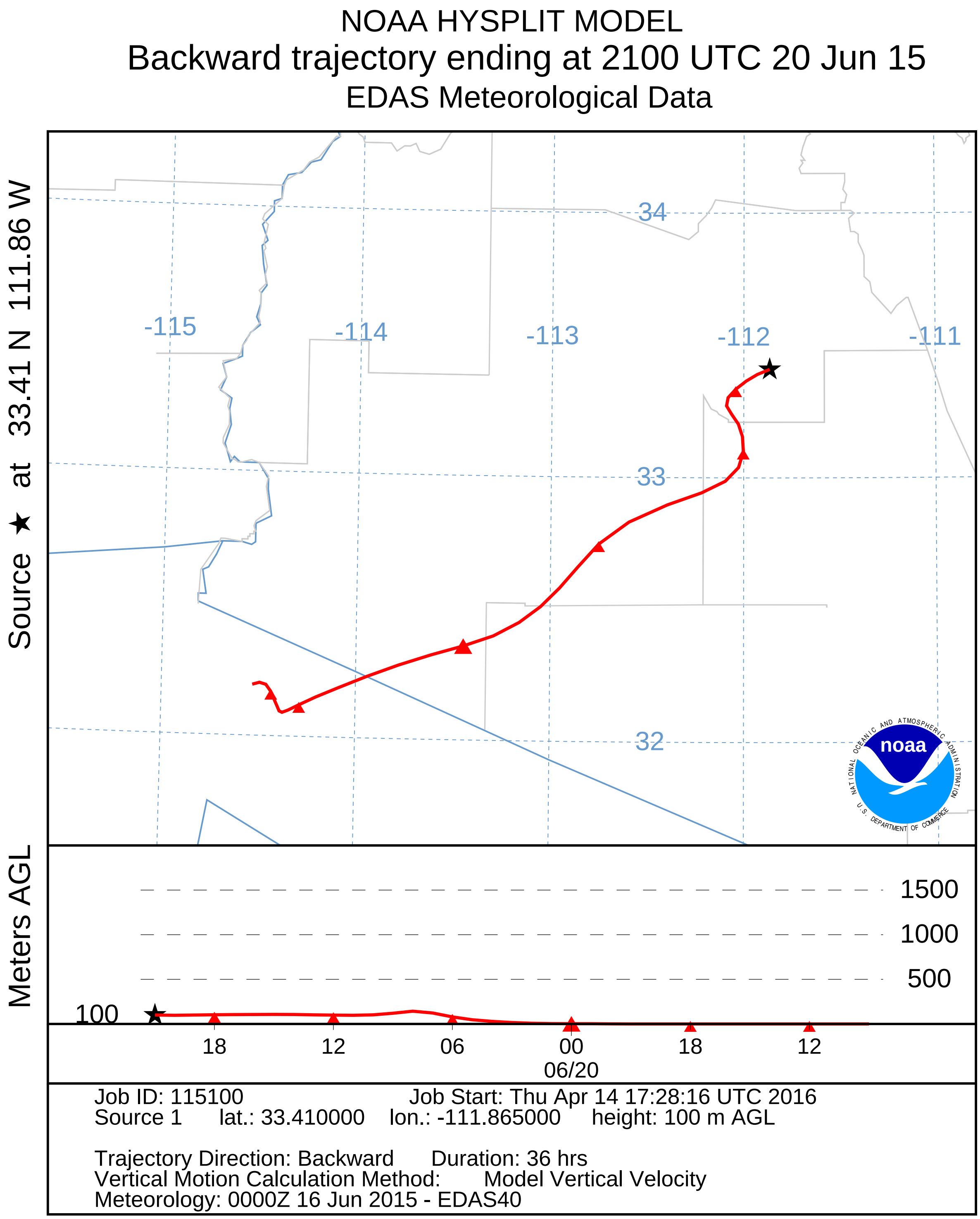
Job ID: 115148 Job Start: Thu Apr 14 17:30:02 UTC 2016
Source 1 lat.: 33.452000 lon.: -111.733000 height: 100 m AGL

Trajectory Direction: Backward Duration: 36 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 16 Jun 2015 - EDAS40

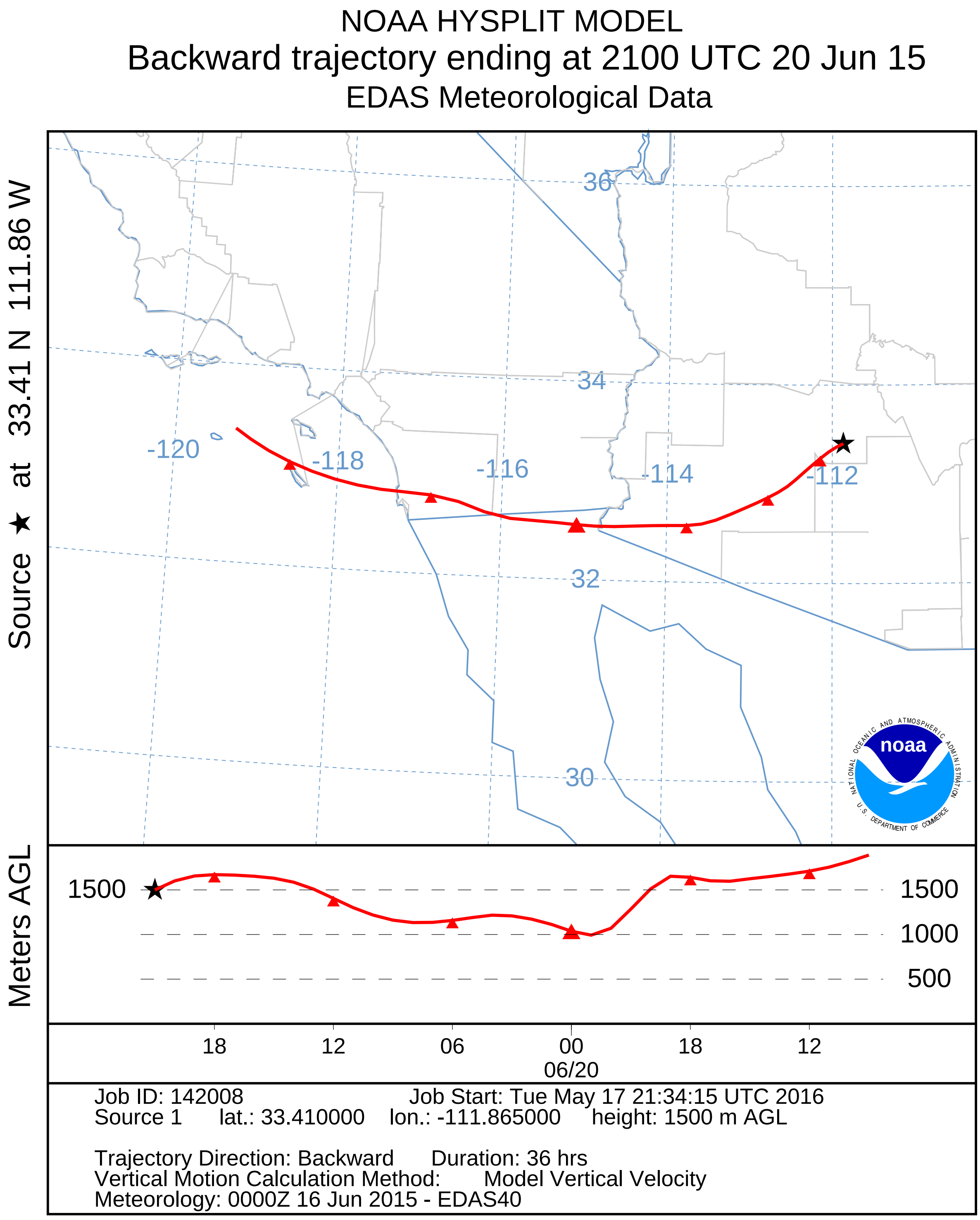
Falcon Field - 1500 meters



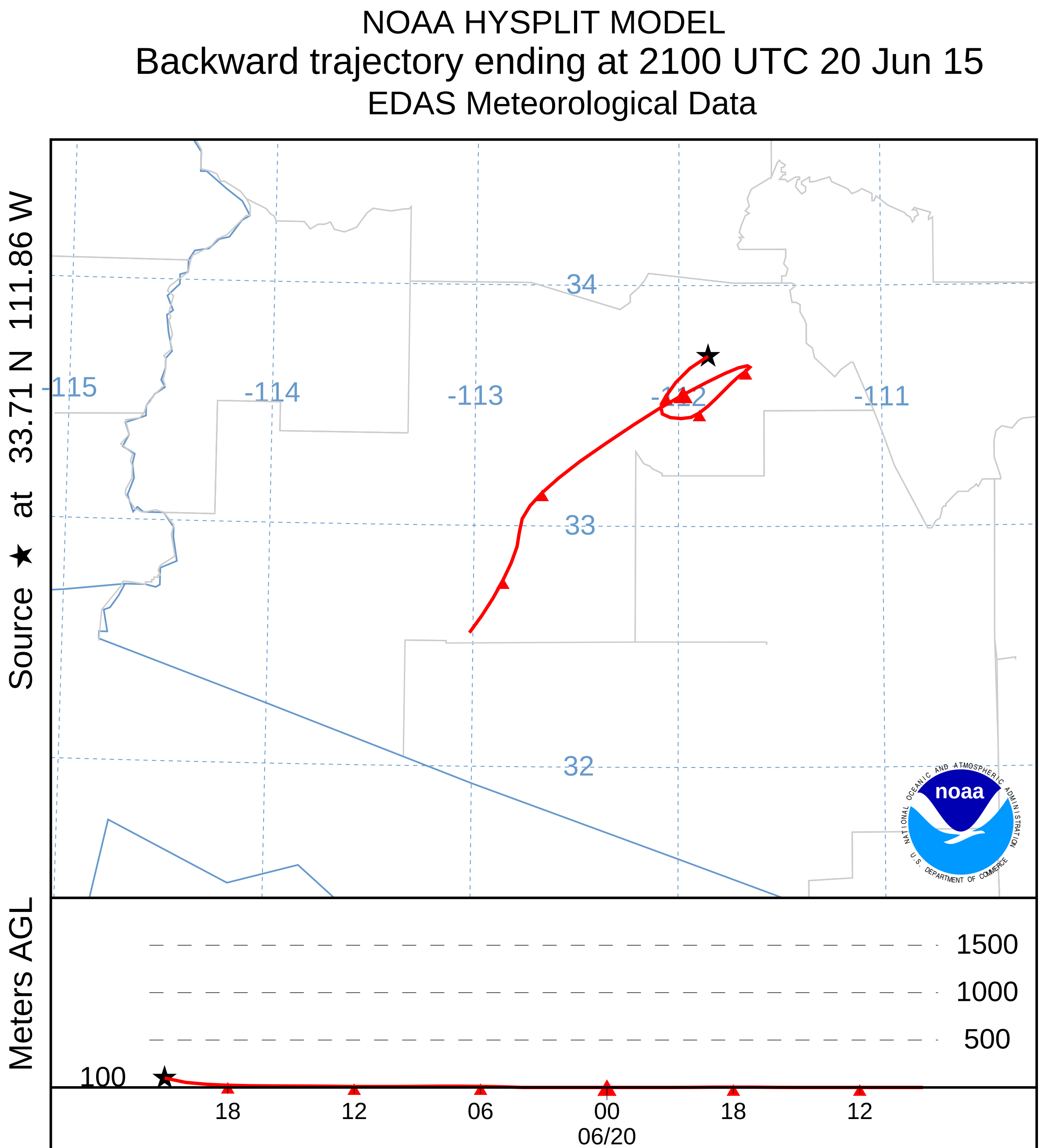
Mesa - 100 meters



Mesa - 1500 meters



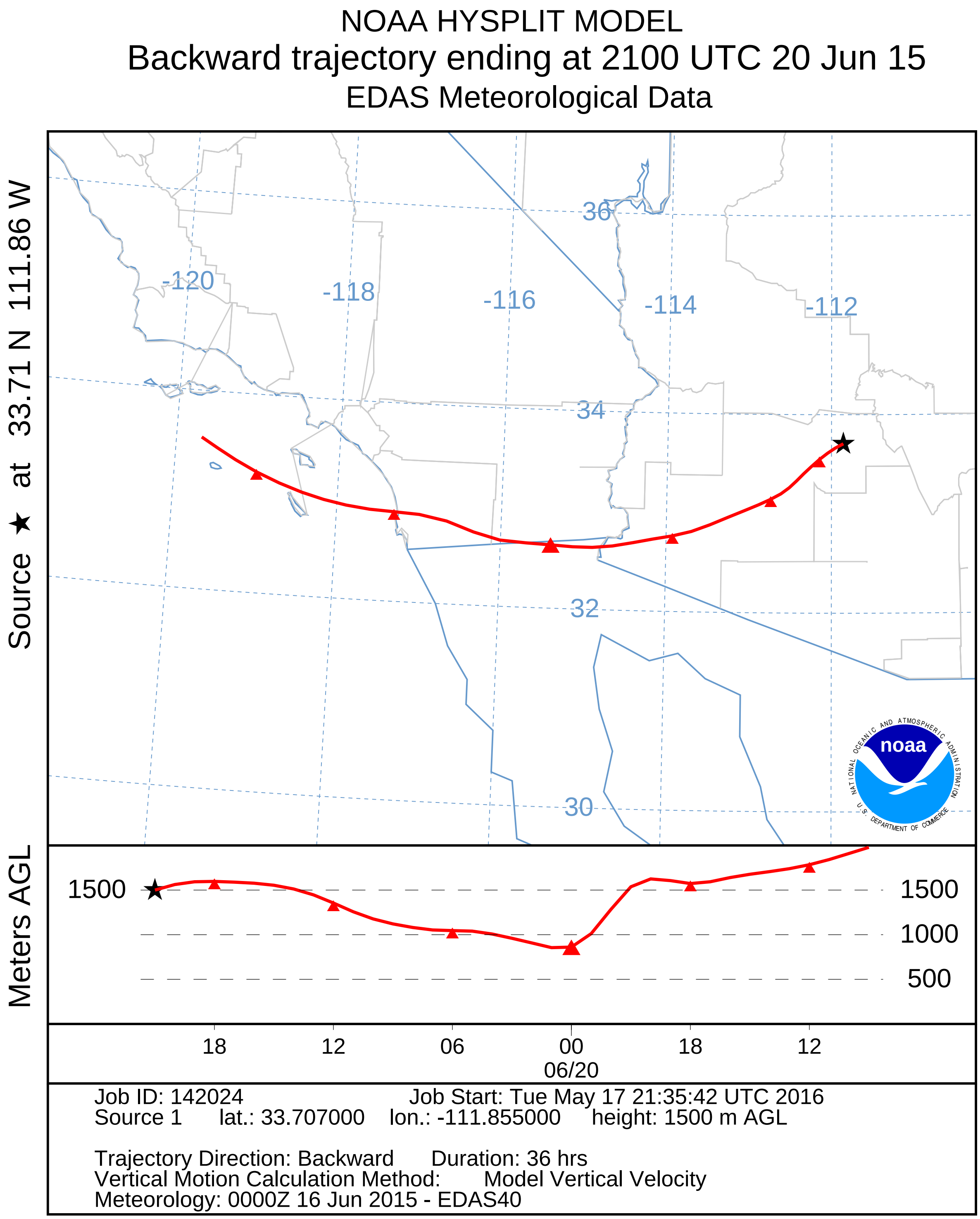
Pinnacle Peak - 100 meters



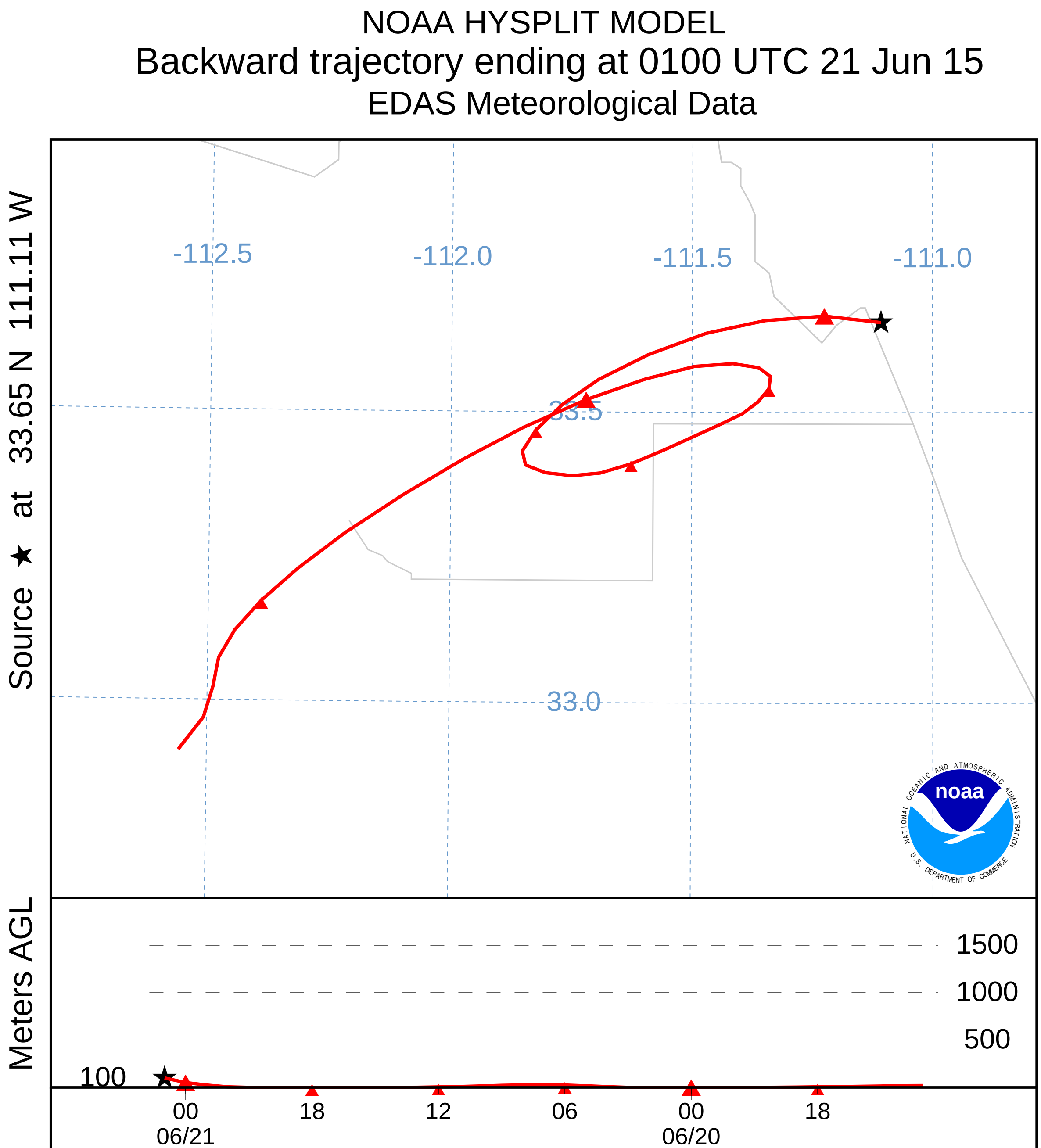
Job ID: 115045 Job Start: Thu Apr 14 17:25:47 UTC 2016
Source 1 lat.: 33.707000 lon.: -111.855000 height: 100 m AGL

Trajectory Direction: Backward Duration: 36 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 16 Jun 2015 - EDAS40

Pinnacle Peak - 1500 meters



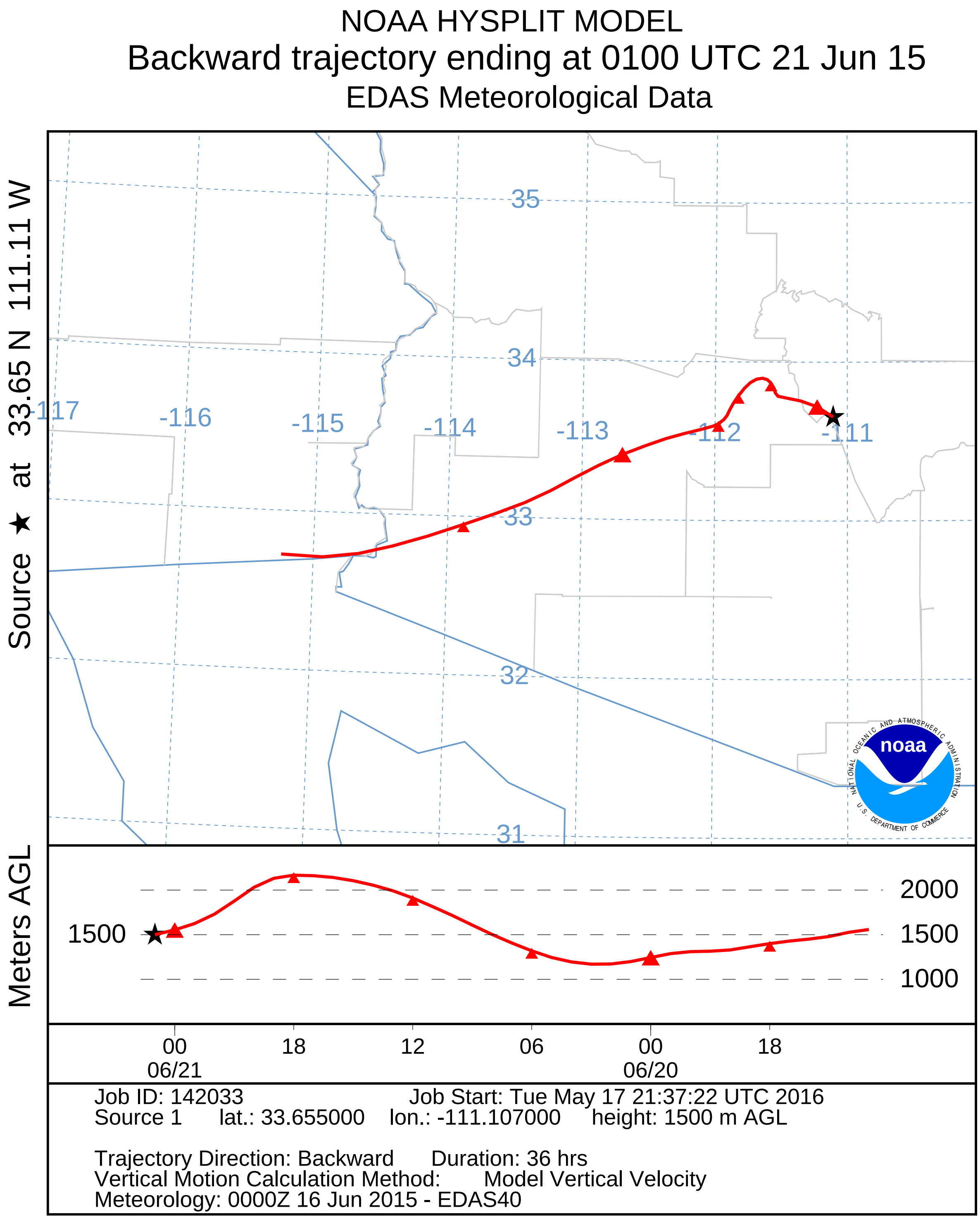
Tonto National Monument - 100 meters



Job ID: 115002 Job Start: Thu Apr 14 17:22:13 UTC 2016
Source 1 lat.: 33.655000 lon.: -111.107000 height: 100 m AGL

Trajectory Direction: Backward Duration: 36 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 16 Jun 2015 - EDAS40

Tonto National Monument - 1500 meters



APPENDIX D

REGRESSION ANALYSIS

Introduction

EPA's draft Wildfire Guidance recommends using multiple variable regression analysis as one tool that can provide additional evidence that ozone and ozone precursor emissions from a wildfire caused or significantly contributed to an ozone exceedance. Multiple variable regression analysis was utilized in this documentation as a statistical method to quantitatively predict the impact the Lake Fire had on six monitors in (or very near) the Maricopa nonattainment area which exceeded the 2008 ozone NAAQS on June 20, 2015.

Multiple variable regression analysis is a statistical method for defining and quantifying the relationship of multiple independent variables (e.g., temperature, humidity, and atmospheric pressure) to a dependent variable (ozone concentrations). Using a statistically significant data set (historical ozone concentrations and meteorological data), the results of the regression analysis produce an equation that can then be used to predict the dependent variable (ozone concentrations) given a set of known independent variables (meteorological measurements). When the predicted value deviates substantially from the observed value, the assumption is the observed value is atypical and independent variables other than those already included in the regression analysis (e.g., unusual emissions from a wildfire) are likely responsible for the increase or decrease from the predicted value.

This Appendix provides details on the development, performance and results of the regression analysis models used to predict typical ozone concentrations at the exceeding monitors on June 20, 2015 in the Maricopa nonattainment area. A summary overview of this information is included in the main body of this report.

Regression Analysis Development

Variable Selection

For this demonstration, the regression analysis equations used to predict maximum daily eight-hour ozone concentrations at each of the six exceeding monitors on June 20, 2015, was developed using observed meteorological and ozone concentration data in the month of June for the years 2010-2015. Monitors located at the Apache Junction, Blue Point, Falcon Field, and Tonto National Monument sites have a full data record of ozone concentrations for June 2010-2015, minus a few days when the monitor was down for maintenance or repair. The Pinnacle Peak monitor was not operational in June 2012 and has no ozone data for that period. The Mesa monitor did not begin monitoring until 2013 and therefore only has ozone data for the period of June 2013-2015.

Historical data was limited to the month of June, instead of the entire ozone season (April-September), as the other months in the ozone season operate under different meteorological regimes. April and May are frequently influenced by advancing cold fronts that can produce high winds and may contain interstate/international transport of ozone and stratospheric intrusion of ozone. In the months of July-September, the nonattainment area is dominated by monsoon season meteorological conditions which can produce frequent thunderstorms, lightning NO_x and heavy precipitation. In contrast, June is characterized by relatively dry, hot, and low-wind meteorological conditions. For these reasons, historical data for the regression analysis was limited to the month of June.

Over 30 meteorological variables were initially evaluated as independent variables for the regression analysis. Meteorological variables that showed no correlation (positive or negative) with ozone concentrations were eliminated early in the process (e.g., precipitation totals) and were not included for further evaluation. All surface meteorological variables (except solar radiation) are taken from measurements at the Sky Harbor International Airport and upper air variables are taken from weather balloons launched at the Tucson International Airport. Table D–1 lists the meteorological variables considered as possible independent variables for the statistical analysis.

Table D–1. Meteorological Variables Considered for Inclusion as Independent Variables in the Regression Analysis.

INDEPENDENT METEOROLOGICAL VARIABLES BY GENERAL CATEGORIES					
Temperature	**Wind Speed/Dir.**	**Humidity**	**Pressure**	**Solar**	**Stability**
Maximum Daily Surface Temp.	Avg. Daily Surface Wind	Avg. Daily Wet Bulb	Avg. Daily Sea-Level Pressure	Avg. Daily Solar Radiation	Difference in Temp. from Surface and 850mb at 0500 Hours
Avg. Daily Surface Temp.	Daily Resultant Surface Wind	Avg. Daily Dew Point	850mb Height at 0500 Hours	Avg. Cloud Cover (0800-1800 Hours)	Difference in Temp. from Surface and 850mb at 1700 Hours
Departure of Surface Temp. from Normal	Avg. Surface Wind from 0651-1151 Hours		850mb Height at 1700 Hours		
Surface Temp. at 0500 Hours	Avg. Surface Wind from 1151-1751 Hours		500mb Height at 0500 Hours		
Surface Temp. at 1700 Hours	Avg. Surface Wind from 0651-1651 Hours		500mb Height at 1700 Hours		
850mb Temp. at 0500 Hours	Avg. Surface Wind from 0651-1951 Hours				
850mb Temp. at 1700 Hours	Surface Wind at 0500 Hours				
500mb Temp. at 0500 Hours	Surface Wind at 1700 Hours				
500mb Temp. at 1700 Hours	850mb Wind at 0500 Hours				
	850mb Wind at 1700 Hours				
	500mb Wind at 0500 Hours				
	500mb Wind at 1700 Hours				

Principal Component Analysis

To avoid including variables that are highly correlated with one another (e.g., maximum surface temperature and average surface temperature), Principal Component Analysis (PCA) (otherwise known as factor analysis) was used to group the variables into statistically unique categories and reduce the complexity in the dataset. Using an eigenvalue of 1 or more, the PCA identified eight distinctive categories of meteorological variables. A maximum of two variables from each category were initially selected for the final regression analysis to avoid the statistical problems associated with multicollinearity, for a total of ten variables. Table D–2 shows the resulting eight categories identified by the PCA and the factor loadings for each of the meteorological variables shown in Table D–1. A high factor loading (close to a value of 1) indicates a strong relationship among the variables in the meteorological category. In general, any variable with an absolute factor loading greater than 0.5 (highlighted in Table D–2) was considered to be a variable that was highly correlated to other variables in the category (large negative values still indicate correlation, but in the opposite direction of high positive values, e.g., solar radiation and cloud cover). Variables chosen for inclusion in the regression analysis from the PCA are represented in red italics in Table D–2.

Table D–2. Principal Component Analysis.

Meteorological Variable from Table D-1	Meteorological Category Factor Loadings							
	Surface Temp. (8.298)*	Afternoon Wind Speed (4.830)*	Humidity / Stability (3.493)*	Pressure (3.166)*	Upper Air Temp. (1.962)*	Cloud Cover (1.925)*	Morning Wind Speed (1.750)*	Upper Air Wind Speed (1.261)*
Avg. Daily Sea-Level Pressure	-.287	-.105	.047	*.925*	-.063	.032	-.010	-.113
500mb Height at 0500	.764	.002	.060	.406	.346	.177	-.080	-.044
850mb Height at 0500	.258	.020	.142	.892	.046	.094	-.014	-.082
500mb Height at 1700	.753	-.047	.058	.472	.375	.063	-.048	-.069
850mb Height at 1700	.153	-.055	.013	.945	-.007	-.034	-.006	-.060
Avg. Daily Dew Point	.183	.100	*.857*	.087	.019	.303	.012	-.017
Average Daily Wet Bulb	.488	.113	.769	.078	.066	.260	-.002	-.007
Average Daily Surface Temp.	.903	.077	.351	.016	.084	-.015	-.098	.047
Max. Daily Surface Temp.	*.965*	-.047	.069	.009	.048	-.126	-.075	.036
Depart. of Temp. from Normal	.832	.080	.199	-.068	-.013	.025	-.165	-.031
Surface Temp. at 0500	.702	.217	.585	.002	.110	.100	-.091	.019
500mb Temp. at 0500	.143	-.125	.030	-.084	*.901*	-.015	-.074	-.014
850mb Temp. at 0500	.932	.149	-.160	-.056	.060	.105	-.075	.005
Diff. in Temp. at 0500	-.080	.121	*.906*	.060	.076	.017	-.037	.019
Surface Temp. at 1700	.954	-.045	.071	.025	.057	-.166	-.112	.048
500mb Temp. at 1700	.262	-.106	.095	.085	.856	-.067	-.078	-.020
850mb Temp. at 1700	.907	-.016	-.216	-.101	.128	.047	.009	-.063
Difference in Temp. at 1700	.491	-.058	.419	.182	-.071	-.362	-.214	.172
Avg. Cloud Cover	-.008	.018	.135	.115	-.100	*.799*	-.045	.170
Avg. Daily Solar Radiation	.090	-.108	-.363	.000	-.046	-.816	-.082	.138
Avg. Daily Surface Wind Speed	.055	.834	.203	-.029	-.111	.050	.349	.096
Daily Resultant Surface Wind Speed	.050	.716	.433	-.019	-.064	.097	-.084	.058
Surface Wind Speed at 0500	-.202	.002	-.161	.031	-.102	.048	.691	.130
Avg. Surface Wind Speed 0651-1151	-.234	.442	.096	-.093	-.059	-.011	*.731*	-.017
Surface Wind Speed at 1700	.100	.769	-.072	-.007	.048	.082	-.401	.058
Avg. Surface Wind Speed 1151-1751	.053	*.952*	-.010	-.038	-.037	.029	-.131	.118
Avg. Surface Wind Speed 0651-1651	-.108	.870	.051	-.041	-.059	.005	.410	.059
Avg. Surface Wind Speed 0651-1951	-.015	.922	.037	-.056	-.115	-.010	.261	.107
500mb Wind Speed at 0500	-.544	.154	-.248	-.166	-.048	.266	.052	.218
850mb Wind Speed at 0500	.082	.115	.090	-.177	.039	-.086	.198	*.759*
500mb Wind Speed at 1700	-.600	.152	-.217	-.243	-.130	.277	.024	.238
850mb Wind Speed at 1700	-.202	.283	-.064	-.061	-.086	.185	-.079	*.631*

**Eigenvalue of category.*
Note: Wind direction variables are not included in the PCA, as wind direction is represented as a categorical variable and not a scalar variable. Only scalar variables can be quantitatively evaluated in the PCA.

The ten variables identified in the PCA were subsequently correlated against the maximum daily eight-hour average ozone concentrations at each exceeding monitor as a second check on the appropriateness of including the variables in the final regression analysis. All but one of the ten variables had statistically significant relationships (significance value of 0.05 or less) with at least half of the ozone concentrations at the six exceeding monitors. As a result of this analysis, it was determined that the variable “850mb

Wind Speed at 0500 Hours" should not be included in the regression analysis, as this variable had no statistically significant relationship with any of the ozone concentrations at the exceeding monitors. Table D–3 displays the bi-variate correlation results each of the ten variables has with the ozone concentrations at the six exceeding monitors. The nine variables selected correspond well with variables selected in other similar regression analyses performed by EPA and other researchers[1].

Table D–3. Correlation of Variables from the PCA with the Ozone Concentrations at the Six Exceeding Monitors.

Correlation with Maximum Daily Eight-Hour Average Ozone Concentrations at Each Monitor							
Meteorological Variable	**Statistics**	**Apache Junction**	**Blue Point**	**Falcon Field**	**Mesa**	**Pinnacle Peak**	**Tonto Nat. Monument**
Avg. Daily Sea-Level Pressure	Pearson Correlation	-.086	-.260	-.194	-.359	-.264	-.222
	Sig. (2-tailed)	.253	***.000***	***.009***	***.001***	***.001***	***.003***
	N	180	179	179	90	150	172
Avg. Daily Dew Point	Pearson Correlation	-.037	-.212	-.061	-.149	-.310	-.244
	Sig. (2-tailed)	.624	***.004***	.420	.161	***.000***	***.001***
	N	180	179	179	90	150	172
Max. Daily Surface Temp.	Pearson Correlation	.214	.233	.343	.388	.216	.210
	Sig. (2-tailed)	***.004***	***.002***	***.000***	***.000***	***.008***	***.006***
	N	180	179	179	90	150	172
500mb Temp. at 0500	Pearson Correlation	.092	.197	.164	.040	.036	.197
	Sig. (2-tailed)	.222	***.009***	***.030***	.713	.666	***.010***
	N	177	176	176	87	147	169
Diff. in Temp. at 0500	Pearson Correlation	-.186	-.283	-.214	-.272	-.349	-.311
	Sig. (2-tailed)	***.013***	***.000***	***.004***	***.011***	***.000***	***.000***
	N	177	176	176	87	147	169
Avg. Cloud Cover	Pearson Correlation	-.045	-.139	-.005	-.149	-.212	-.187
	Sig. (2-tailed)	.549	.064	.942	.160	***.009***	***.014***
	N	180	179	179	90	150	172
Avg. Surface Wind Speed 0651-1151	Pearson Correlation	-.262	-.317	-.265	-.400	-.188	-.187
	Sig. (2-tailed)	***.000***	***.000***	***.000***	***.000***	***.021***	***.014***
	N	180	179	179	90	150	172
Avg. Surface Wind Speed 1151-1751	Pearson Correlation	-.106	-.171	-.200	-.316	-.336	-.097
	Sig. (2-tailed)	.157	***.022***	***.007***	***.002***	***.000***	.204
	N	180	179	179	90	150	172
850mb Wind Speed at 0500 (not selected)	Pearson Correlation	-.045	-.080	-.059	-.062	-.097	.003
	Sig. (2-tailed)	.557	.292	.437	.568	.243	.973
	N	176	175	175	86	146	168
850mb Wind Speed at 1700	Pearson Correlation	-.181	-.173	-.261	-.308	-.275	-.187
	Sig. (2-tailed)	***.016***	***.021***	***.000***	***.003***	***.001***	***.015***
	N	177	176	176	88	148	169

Final Variable Selections

In addition to the nine meteorological variables identified in the PCA, categorical variables were also included as independent variables in the regression analysis. The categorical variables include: (1) the wind direction measurements that correspond to the selected wind speed measurements in Table D–3 to

[1] California Air Resources Board, (2011). Exceptional Events Demonstration for 1-Hour Ozone Exceedances in the Sacramento Regional Nonattainment Area Due to 2008 Wildfires. Camalier et al., (2007). The effects of meteorology on ozone in urban areas and their use in assessing ozone trends. Atmospheric Environment 41, 7127-7137.

account for air flow direction, and (2) the day of the week (e.g., Monday) to account for differences in emissions between weekdays and weekends. Because wind direction is a circular measurement, the variable must undergo significant transformations if wind speed is to be represented as a scalar variable in the regression analysis (i.e., wind direction as measured in degrees would need to be transformed by taking the sine and cosine of the degree measurement). To avoid the issues associated with transformations of wind direction measurements, the wind direction was represented as one of eight categorical variables (e.g., north-northwest, east-southeast, etc.).

One additional scalar independent variable, the prior-day maximum eight-hour average ozone concentration as measured at each exceeding monitor, was included in the final regression analysis models. The inclusion of this variable not only improves the performance of the regression analysis, but also is an important predictor of future ozone concentrations as ozone concentrations can build from one day to the next under the typical stagnant meteorological conditions seen in June in the Maricopa nonattainment area. The final 14 independent variables included in the regression analysis models are listed in Table D–4.

Table D–4. Independent Variables in the Regression Analysis.

Independent Variable Abbreviation	Description
MaxTemp*	Maximum Daily Surface Temperature
UpTemp*	Upper Air (500 mb) Temperature at 0500 Hours
DiffTemp*	Difference in Temperature Between Surface and Upper Air (850 mb) at 0500 Hours
DewPoint*	Average Daily Dew Point
Pressure*	Average Daily Sea-Level Pressure
MornWind*	Average of Morning Hours (0651-1151 Hours) Surface Wind Speed
AftWind*	Average of Afternoon Hours (1151-1751 Hours) Surface Wind Speed
UpWind*	Upper Air (850 mb) Wind Speed at 1700 Hours
Cloud*	Average of Daylight Hours (0800-1800 Hours) Cloud Cover
MornDir	Average of Morning Hours (0651-1151 Hours) Surface Wind Direction
AftDir	Average of Afternoon Hours (1151-1751 Hours) Surface Wind Direction
UpDir	Upper Air (850 mb) Wind Direction at 1700 Hours
Day	Day of the Week
Prior	Prior-Day Maximum Eight-Hour Average Ozone Concentration

**Variable selected from Principal Component Analysis (PCA)*

Normality of Selected Variables

Before the regression analysis was run in the statistical software, the selected variables (independent and dependent) were analyzed for normality. Some independent variables such as wind speed and cloud cover exhibited a moderate positive skew in their distribution, while maximum temperature exhibited a negative skew in its distribution. Maximum daily eight-hour average ozone concentrations (dependent variable) also exhibit a positive skew in some cases and are often transformed in other studies using a log function to make the distribution of the data more normal. Figure D–1 includes sample histograms of the positive and negative skew of some of the variables included in the regression analysis.

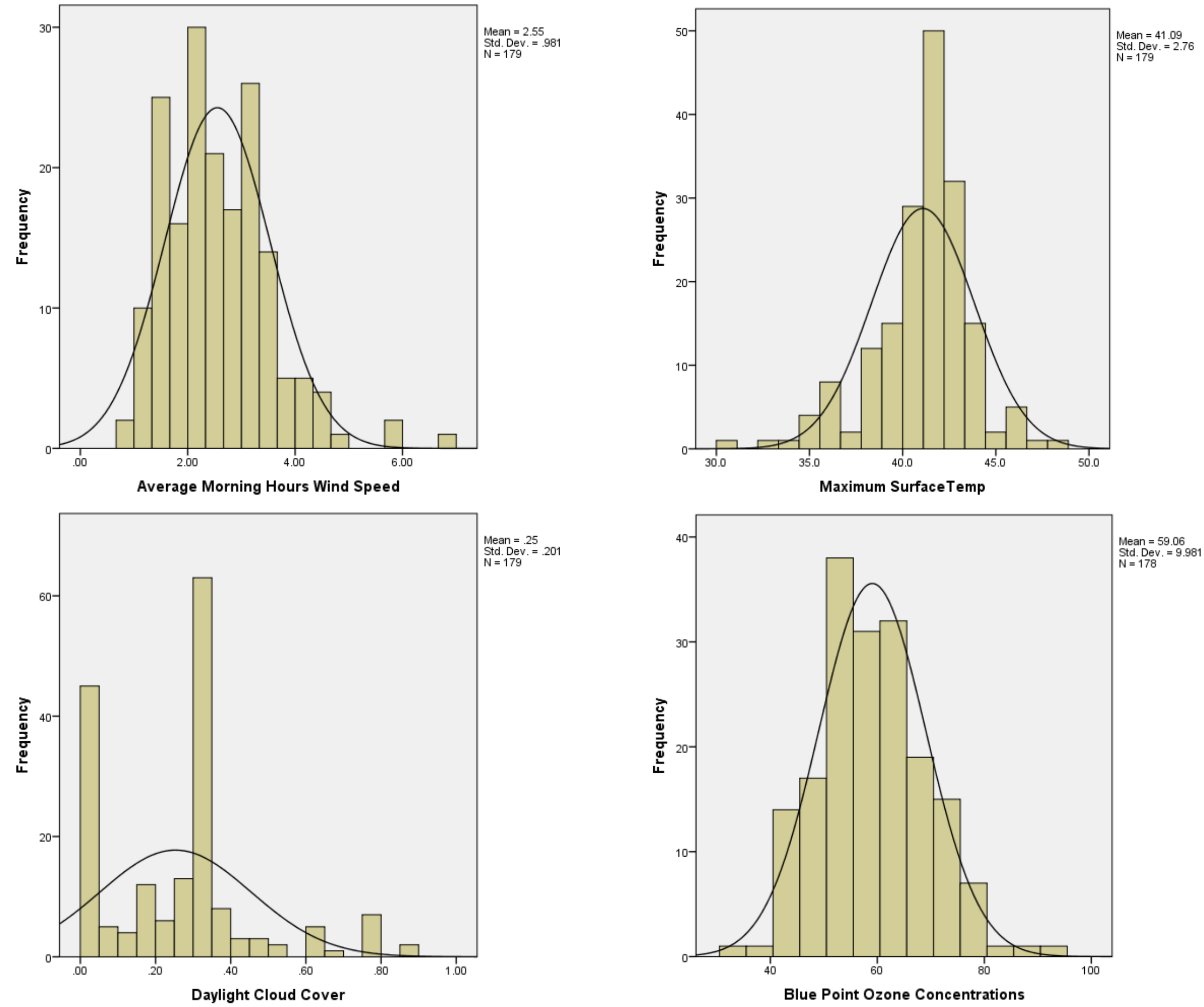


Figure D–1. Positive and negative skew of sample regression analysis variables.

During regression analysis model testing, the variables that did exhibit statistically significant skews were tested as transformed variables using a log or power function. Comparison of regression analysis results found no significant improvement in model performance or prediction using variables that had been transformed; with some cases showing diminished performance. This is likely due to the fact that while some of the data did exhibit some skew, the moderateness of the skew was not affecting model performance significantly. As such, the original form of all variables was used in the final regression analysis models.

Regression Analysis Performance

Regression Analysis Specifications

Using the independent variables listed in Table D–4 and the monitor-specific daily maximum eight-hour average ozone concentration dependent variable, the regression analysis was run for each of the six monitors that exceeded on June 20, 2015. This produced a unique regression equation for each of the exceeding monitoring sites that can be used to predict ozone concentrations with the set of known independent variables. The regression analysis was run using IBM SPSS statistical software. Several options for running the regression analysis were considered and tested, including controlling criteria such as the *F*-statistic, AIC Criterion, and the Over-Fit Prevention Criterion, which sets aside a random portion of the data set that is not used to train the regression model equations. All of these options produced relatively similar ozone concentration predictions, generally within 2 ppb of each other. The following bullets list the parameters that were ultimately selected for use in running the regression analysis models:

- The independent variables were processed using the SPSS automatic data preparation tool. This tool improves the accuracy and reliability of the regression model by trimming outlying values (to a maximum of three standard deviations) and merges categorical variables that have similar associations with the dependent variable (ozone concentration).
- The regression analysis models were processed using the best subset of multiple forward stepwise selections. Stepwise selection starts with no effects (independent variables) in the model and then adds and removes effects one step at a time until no more can be added or removed according to the stepwise criteria.
- The criterion used to control the stepwise selection is based upon the adjusted R^2 criterion. The adjusted R^2 criterion is based on the fit of the training set, and is adjusted to penalize overly complex models.
- At each step, the effect that corresponds to the greatest positive increase in the criterion is added to the model. Any effects in the model that correspond to a decrease in the criterion are removed.
- No variables were forced to remain in the regression analysis model.

Performance

The performance of each of the regression analysis models is shown in Table D–5. The table includes the adjusted R^2 value, *F*-statistic and significance (*p*) of each of the regression analysis models. The overall measure of how well the regression analysis is able to explain the observed ozone concentration is listed as the adjusted R^2 value. The adjusted R^2 values range between 0.498 to 0.584 and are comparable to adjusted R^2 values seen in other similar analyses using observed meteorological data[2]. The *F*-statistics for all of the models are statistically significant (*p* value less than 0.05), indicating that the independent variables can be relied upon to predict the dependent variable (ozone concentrations).

A visual analysis of the performance of the regression analysis models is included in the scatterplots of the predicted versus observed ozone concentrations in Figure D–2. The scatterplots for each of the six exceeding monitoring sites indicate that the regression models show the expected positive correlation between predicted and observed ozone concentrations. The scatterplots are generally clustered around the

[2] California Air Resources Board, (2011). Exceptional Events Demonstration for 1-Hour Ozone Exceedances in the Sacramento Regional Nonattainment Area Due to 2008 Wildfires. Jaffe et al., (2013). Impact of Wildfires on Ozone Exceptional Events in the Western U.S. Environmental Science & Technology 47, 11065-11072.

trend line, with some outlying points, and are typical for the adjusted R^2 values produced by the regression equation models.

Table D–5. Regression Analysis Performance Statistics.

Monitor	Adjusted. R^2	*F*	Significance (*p*)
Apache Junction – Model Summary	0.559	25.632	0.000
Blue Point – Model Summary	0.508	18.966	0.000
Falcon Field – Model Summary	0.493	16.379	0.000
Mesa – Model Summary	0.562	10.213	0.000
Pinnacle Peak – Model Summary	0.498	14.054	0.000
Tonto Nat. Monument – Model Summary	0.584	19.052	0.000

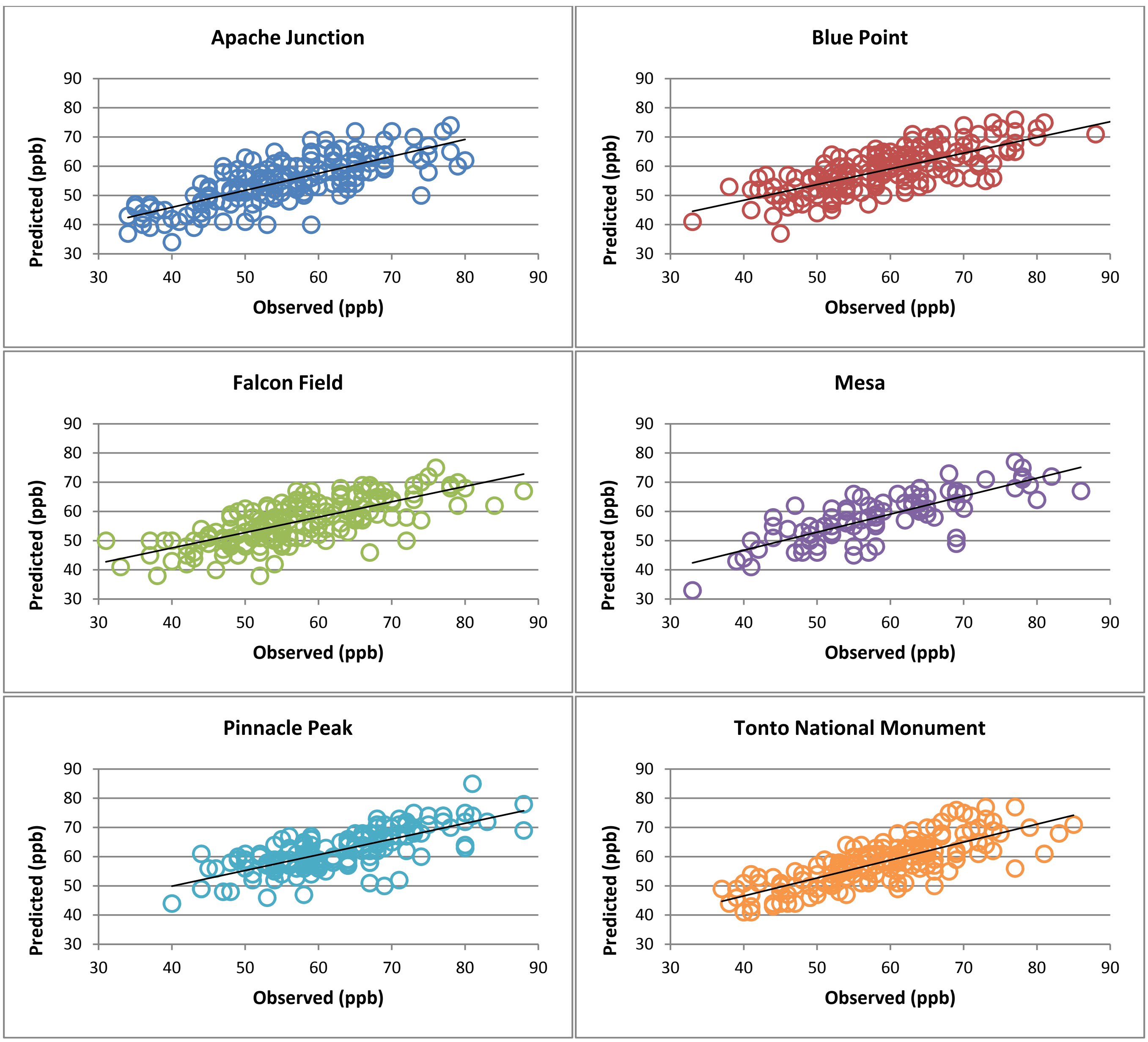


Figure D–2. Scatterplots of predicted and observed ozone concentrations.

Table D–6 lists the coefficient, importance, *t*-statistic, *p* value, and standard error of the independent variables for each of the six exceeding monitors' regression analysis models. The abbreviations of the independent variables in Table D–6 correspond to the abbreviations listed in Table D–4. The *t*-statistic measures the size of the difference relative to the variation in the data and the standard error shows how much the average of the variable deviates from the expected mean of that variable. A *p* value less than 0.05 normally indicates that the independent variable is statistically significant. While minimally important, the regression models have chosen to include some independent variables with *p* values greater than 0.05 since they contribute to overall model performance, reliability or accuracy. All categories in a categorical variable are included, even if only one of the categories is statistically significant (i.e., the wind direction NNW is statistically significant, but the other seven are not).

The independent variables in Table D–6 that are included in each monitoring site's regression analysis are not identical in each model. This is not unexpected given that the monitoring sites are situated in disparate locations including dense-urban (Mesa), suburban (Pinnacle Peak) and rural locations (Tonto Nat. Monument), which allow for different interactions between meteorology and the NO_X and VOC precursor emissions that lead to ozone formation. Despite some variation, all monitoring sites were significantly influenced by the prior day ozone concentration, atmospheric stability and/or pressure measurements, and multiple wind speed and direction measurements.

An examination of the resulting coefficients in Table D–6 shows that the coefficients are generally reflective of common knowledge regarding the production of ozone. As an example, the sign of the coefficients for all wind speeds is negative, meaning as wind speed increases, ozone production decreases. One variable that has a counter-intuitive coefficient in Table D–6 is the maximum daily surface temperature variable (MaxTemp). The sign of the coefficient is negative for the Apache Junction and Tonto National Monument monitors (MaxTemp is not statistically important enough to be included in the other four monitoring site's regression analyses) which suggest that as temperature increases, ozone decreases at these monitoring sites. An examination of the scatterplots of MaxTemp and the maximum daily eight-hour ozone concentration at these two monitoring sites (Figure D–3) do reveal an extremely weak, but positive, linear correlation between MaxTemp and ozone (R^2 values of 0.039 to 0.041) that seems to contradict a negative sign for the MaxTemp coefficient. However, given the heavy scatter and extremely weak linear correlation between temperature and ozone in the scatterplots, outlier values may heavily influence and easily shift the sign of the coefficient. As the data was processed to trim outlier values greater than three standard deviations, it is also possible that this process helped to produce a negative correlation between MaxTemp and ozone. In reality, it is also probable that an increase in temperature (e.g., 108°F to 112°F) may have little, to no impact on ozone production since extreme high temperatures typically are present for all days in the month of June.

Table D–6. Coefficient, Importance, *t*-statistic, *p*-value and Standard Error for each Regression Model.

Monitoring Site	Model Variables	Coefficient	Importance	*t*	*p*	Std. Error
Apache Junction	Prior	0.508	0.635	9.422	0.000	0.054
Apache Junction	UpDir = NNE, WSW	-5.736	0.141	-4.291	0.000	1.337
Apache Junction	UpDir = ESE, SSW	-6.961	0.141	-2.703	0.008	2.576
Apache Junction	UpDir = ENE, NNW, SSE, WNW	0.000	0.141			
Apache Junction	MornDir = SSE	-4.274	0.092	-3.075	0.002	1.390
Apache Junction	MornDir = ENE, NNW	1.791	0.092	1.216	0.226	1.472
Apache Junction	MornDir = ESE, NNE, SSW, WNW, WSW	0.000	0.092			
Apache Junction	DiffTemp	-0.733	0.070	-3.120	0.002	0.235
Apache Junction	AftDir = ENE, NNE, SSE, SSW	-3.230	0.027	-1.944	0.054	1.661
Apache Junction	AftDir = ESE, NNW, WNW, WSW	0.000	0.027			
Apache Junction	MaxTemp	-0.406	0.021	-1.700	0.091	0.239
Apache Junction	MornWind	-0.978	0.015	-1.445	0.150	0.677
Apache Junction	Intercept	52.414		5.046	0.000	10.386
Blue Point	Prior	0.392	0.432	6.774	0.000	0.058
Blue Point	Updir = ESE, SSW	-6.269	0.141	-2.519	0.013	2.488
Blue Point	UpDir = ENE, WSW	-4.577	0.141	-3.567	0.000	1.283
Blue Point	UpDir = NNE, NNW, SSE, WNW	0.000	0.141			
Blue Point	DewPoint	-0.207	0.134	-3.767	0.000	0.055
Blue Point	MornDir = SSE	-3.976	0.079	-2.904	0.004	1.369
Blue Point	MornDir = ENE, ESE, NNE, NNW, SSW, WNW,	0.000	0.079			
Blue Point	Day = TUES, WED, THUR, FRI	2.947	0.068	2.683	0.008	1.098
Blue Point	Day = MON, SAT, SUN	0.000	0.068			
Blue Point	Pressure	-23.802	0.060	-2.514	0.013	9.467
Blue Point	AftDir = ENE, SSE, SSW	-3.674	0.040	-2.050	0.042	1.792
Blue Point	AftDir = ESE, NNE, NNW, WNW, WSW	0.000	0.040			
Blue Point	AftWind	-0.845	0.029	-1.751	0.082	0.483
Blue Point	MornWind	-0.972	0.018	-1.391	0.166	0.699
Blue Point	Intercept	757.381		2.681	0.008	282.482
Falcon Field	Prior	0.355	0.402	5.885	0.000	0.060
Falcon Field	UpDir = WNW	5.333	0.258	3.874	0.000	1.377
Falcon Field	UpDir = ESE, SSW	-0.892	0.258	-0.365	0.716	2.444
Falcon Field	UpDir = ENE, NNW	6.814	0.258	3.967	0.000	1.717
Falcon Field	UpDir = NNE, SSE, WSW	0.000	0.258			
Falcon Field	AftDir = ESE, NNW	8.607	0.087	2.320	0.022	3.709
Falcon Field	AftDir = NNE, WNW, WSW	4.157	0.087	2.272	0.024	1.829
Falcon Field	AftDir = ENE, SSE, SSW	0.000	0.087			
Falcon Field	DiffTemp	-0.638	0.076	-2.565	0.011	0.249
Falcon Field	MornDir = ENE, ESE, NNE, NNW, WSW	3.038	0.060	2.275	0.024	1.335
Falcon Field	MornDir = SSE, SSW, WNW	0.000	0.060			
Falcon Field	Pressure	-21.559	0.060	-2.267	0.025	9.508
Falcon Field	AftWind	-0.943	0.039	-1.841	0.068	0.512
Falcon Field	MornWind	-0.852	0.017	-1.222	0.223	0.697
Falcon Field	Intercept	675.749		2.384	0.018	283.500
Mesa	UpDir = WNW	5.804	0.299	2.912	0.005	1.993
Mesa	UpDir = ENE, ESE, NNE, NNW, SSE	8.974	0.299	3.672	0.000	2.444
Mesa	UpDir = SSW, WSW	0.000	0.299			
Mesa	MornDir = ENE, ESE, NNE, NNW, WSW	5.774	0.169	2.891	0.005	1.997
Mesa	MornDir = SSE, SSW, WNW	0.000	0.169			
Mesa	Pressure	-43.377	0.128	-2.516	0.014	17.243
Mesa	AftWind	-1.671	0.106	-2.291	0.025	0.730
Mesa	AftDir = ENE, ESE	-12.736	0.102	-1.528	0.131	8.336
Mesa	AftDir = NNW	9.912	0.102	1.215	0.228	8.156
Mesa	AftDir = NNE, WNW, WSW	2.435	0.102	0.878	0.383	2.775
Mesa	AftDir = SSE, SSW	0.000	0.102			
Mesa	Prior	0.190	0.099	2.220	0.030	0.086

Monitoring Site	Model Variables	Coefficient	Importance	*t*	*p*	Std. Error
Mesa	DiffTemp	-0.517	0.040	-1.405	0.164	0.368
Mesa	UpTemp	-0.619	0.035	-1.313	0.193	0.471
Mesa	MornWind	-1.208	0.023	-1.064	0.291	1.135
Mesa	Intercept	1332.627		2.593	0.011	513.880
Pinnacle Peak	Prior	0.338	0.331	5.212	0.000	0.065
Pinnacle Peak	Day = SUN	-5.561	0.145	-3.443	0.001	1.615
Pinnacle Peak	Day = MON, TUES, WED, THUR, FRI, SAT	0.000	0.145			
Pinnacle Peak	DewPoint	-0.180	0.132	-3.293	0.001	0.055
Pinnacle Peak	Pressure	-27.286	0.100	-2.858	0.005	9.546
Pinnacle Peak	AftWind	-1.451	0.089	-2.698	0.008	0.538
Pinnacle Peak	MornDir = SSE, SSW, WNW	-3.655	0.086	-2.659	0.009	1.375
Pinnacle Peak	MornDir = ENE, ESE, NNE, NNW, WSW	0.000	0.086			
Pinnacle Peak	UpWind	-0.507	0.037	-1.731	0.086	0.293
Pinnacle Peak	AftDir = NNW	4.084	0.035	0.842	0.401	4.852
Pinnacle Peak	AftDir = ENE, SSE, SSW	-2.692	0.035	-1.449	0.150	1.858
Pinnacle Peak	AftDir = ESE, NNE, WNW, WSW	0.000	0.035			
Pinnacle Peak	UpDir = ESE, NNE, SSE, SSW	-3.877	0.028	-1.526	0.129	2.541
Pinnacle Peak	UpDir = ENE, NNW, WNW, WSW	0.000	0.028			
Pinnacle Peak	MornWind	-0.801	0.017	-1.176	0.242	0.681
Pinnacle Peak	Intercept	871.362		3.057	0.003	285.056
Tonto Nat. Monument	Prior	0.468	0.504	8.369	0.000	0.056
Tonto Nat. Monument	UpDir = WSW	-6.187	0.179	-4.885	0.000	1.267
Tonto Nat. Monument	UpDir = ESE, SSW	-6.406	0.179	-2.759	0.007	2.322
Tonto Nat. Monument	UpDir = ENE, NNE, NNW, SSE, WNW	0.000	0.179			
Tonto Nat. Monument	MornDir = SSE	-5.236	0.099	-3.148	0.002	1.663
Tonto Nat. Monument	MornDir = ENE, ESE, NNW	-1.165	0.099	-0.758	0.450	1.536
Tonto Nat. Monument	MornDir = NNE, SSW, WNW, WSW	0.000	0.099			
Tonto Nat. Monument	Day = MON, SUN	-3.198	0.061	-2.917	0.004	1.096
Tonto Nat. Monument	Day = TUES, WED, THUR, FRI, SAT	0.000	0.061			
Tonto Nat. Monument	DewPoint	-0.189	0.043	-2.449	0.015	0.077
Tonto Nat. Monument	Pressure	-19.635	0.034	-2.178	0.031	9.014
Tonto Nat. Monument	MaxTemp	-0.42	0.023	-1.778	0.077	0.236
Tonto Nat. Monument	AftDir = ENE, NNE, SSE, SSW	-2.476	0.018	-1.598	0.112	1.549
Tonto Nat. Monument	AftDir = ESE, NNW, WNW,WSW	0.000	0.018			
Tonto Nat. Monument	Cloud	-3.789	0.014	-1.386	0.168	2.734
Tonto Nat. Monument	UpTemp	0.359	0.013	1.350	0.179	0.266
Tonto Nat. Monument	DiffTemp	-0.408	0.011	-1.241	0.216	0.329
Tonto Nat. Monument	Intercept	648.285		2.389	0.018	271.308

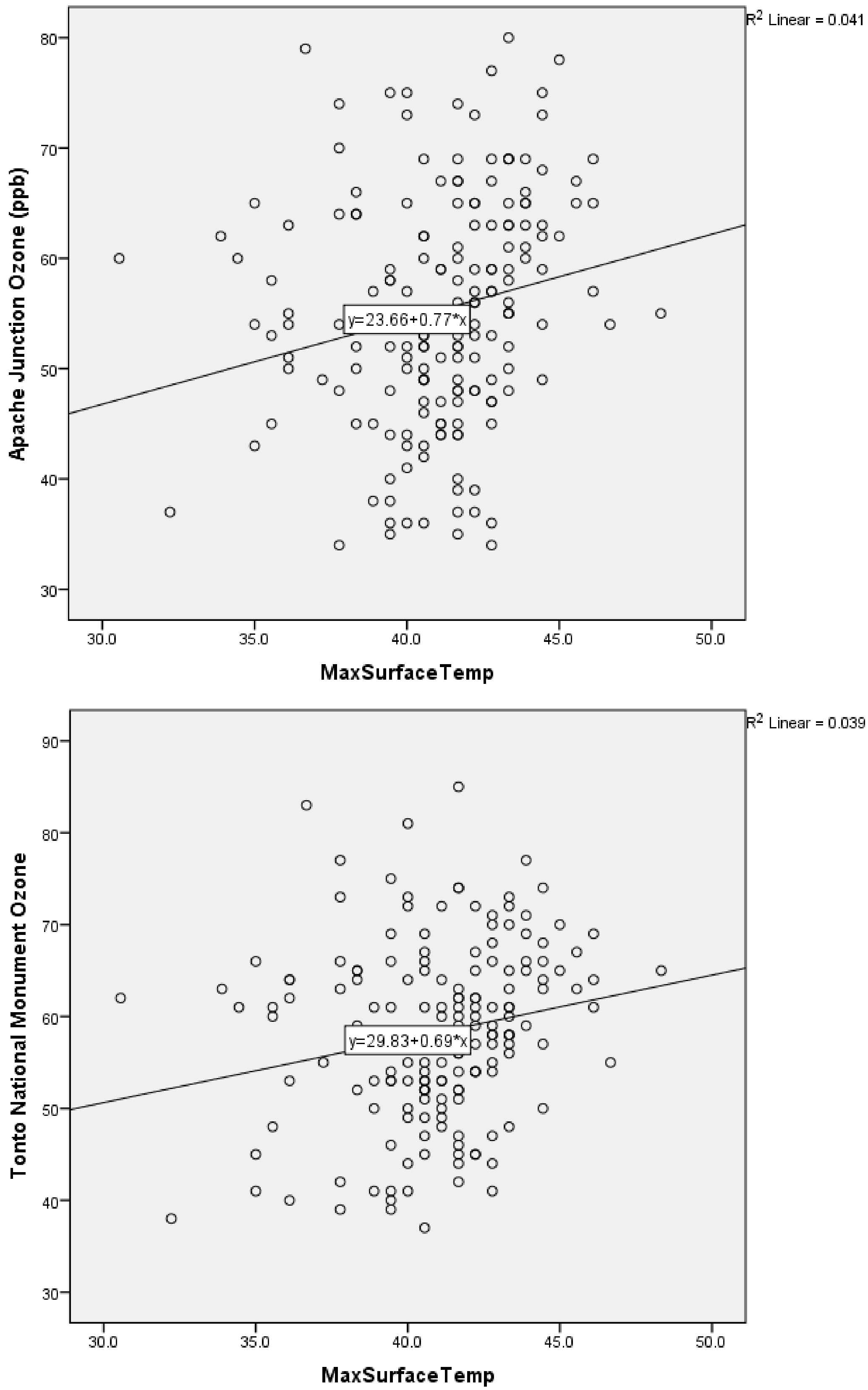


Figure D–3. Scatterplots of MaxTemp and ozone concentrations at two exceeding monitors.

Sample Regression Analysis Equation

The coefficients of the variables in Table D–6 are the values used in combination with observed data to predict ozone concentrations. The predicted ozone concentration is derived by summing the product of the observed meteorological variable by the listed coefficient for that variable (for a categorical variable, the value is either 1 if the variable exists or 0 if the variable does not exist). As an example, the equation below shows the predicted ozone concentration at the Apache Junction monitor on June 20, 2015:

June 20, 2015 meteorological values included in regression analysis model for Apache Junction:
Prior = 65 ppb; UpDir = NNW; MornDir = ESE; DiffTemp = -1.022°C; AftDir = WNW; MaxTemp = 44.444°C; MornWind = 3.129 m/s

Regression analysis equation:

*Predicted Ozone (ppb) = (Prior*0.508) + (UpDir for NNW = 0) + (MornDir for ESE = 0) + (DiffTemp*-0.733) + (AftDir for WNW = 0) + (MaxTemp*-0.406) + (MornWind*-0.978) + (Intercept = 52.414)*

*= (65*0.508) + (0) + (0) + (-1.022*-0.733) + (0) +(44.444*-0.406) + (3.129*-0.978) + (52.414)*

65.1 ppb = (33.020) + (0) + (0) + (.749) + (0) + (-18.044) + (-3.060) + (52.414)

Distribution of Errors

In order to makes sure that the regression models are not biased to systematically predict higher or lower ozone concentrations than the observed concentrations, the distribution of the regression analysis model errors (difference between observed and predicted ozone concentrations) can be examined for high or low bias. If the errors are distributed normally around a mean of zero, the models are not biased to systematically predict high or low ozone concentrations. Histograms of the distribution of errors for the regression analysis models for all six exceeding monitors are included in Figure D–4. The histograms reveal a normal distribution with a slight positive skew. The positive skew is largely the result of truncating ozone concentrations to conform to the ozone NAAQS and is reflected in the mean of errors in a value of approximately 0.5 (instead of zero as would be expected in a completely normal distribution). This bias is very slight and results on average in under predictions of ozone concentrations by 0.0005 parts per million (or 0.5 ppb). A bias this small does not materially affect the regression results.

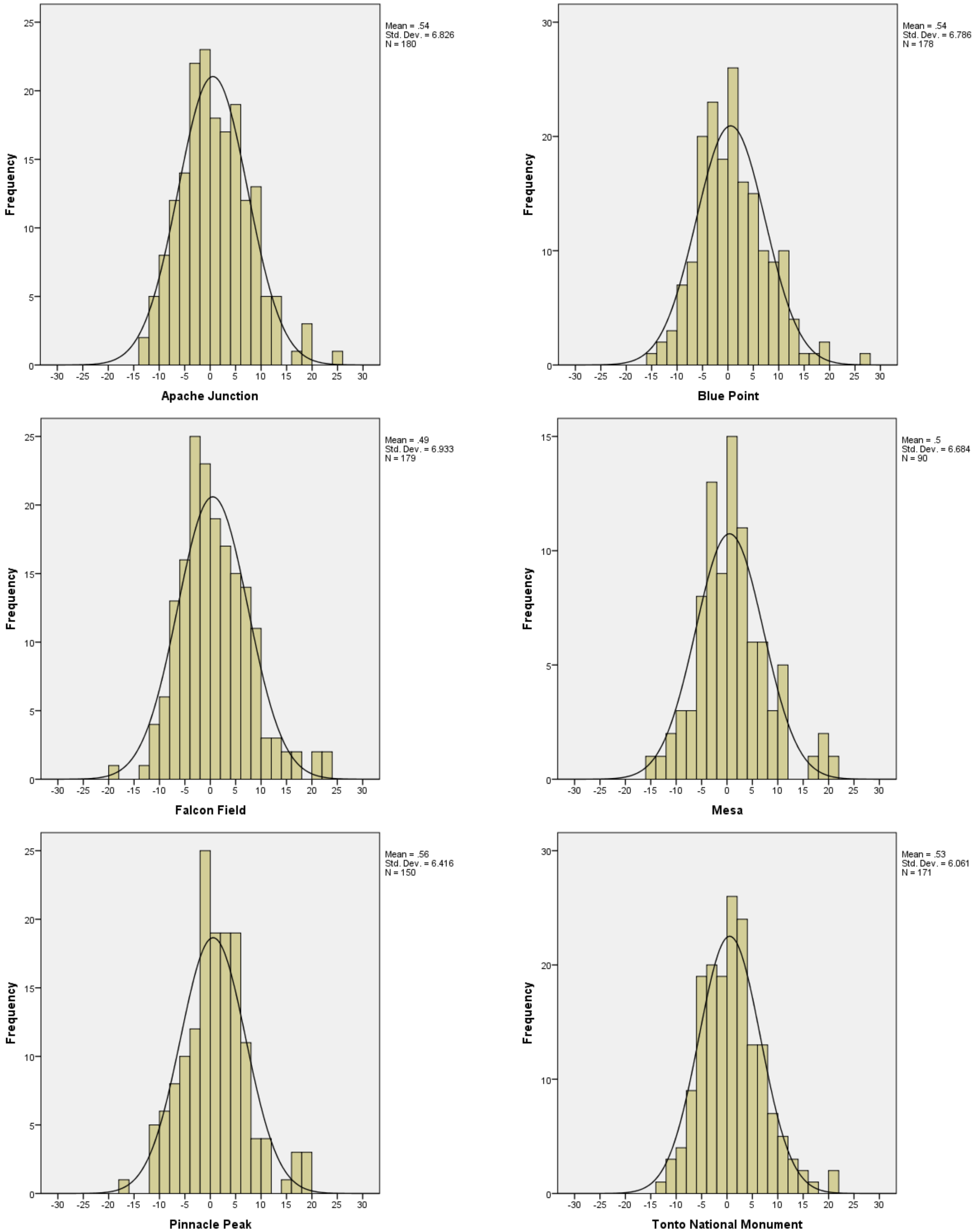


Figure D–4. Histograms of regression analysis model errors (observed - predicted ozone concentrations) at each monitoring site.

Regression Analysis Results

Using the equations developed by the regression analysis models for each of the six exceeding monitoring sites, predicted ozone concentrations are developed for the entire period of June 2010-2015 at each site, excluding days when there were no observed ozone concentrations during this period at the monitoring sites. As shown in the histograms in Figure D–4, the regression equations produce predicted ozone concentrations that are both less than, and greater than, the observed concentrations in a relatively normal distribution (approximately half of the predictions are less than observed, and half are greater than observed). Figure D–5 includes plots of the predicted and observed ozone concentrations in June 2015 at the six monitoring sites.

<u>June 20, 2015 Predictions Results</u>

The results of the regression analysis for each of the monitoring sites predict maximum daily eight-hour ozone values on June 20, 2015 between 0.065 and 0.070 ppm (values truncated to three decimal points in keeping with the form of the standard), well below the 2008 ozone standard of 0.075 ppm. The results confirm the assumption that under the meteorological conditions that existed on June 20, 2015, the monitors would normally not have exceeded the 2008 ozone standard, and suggests that an out-of-the-norm variable (e.g., increased emissions from the wildfire) influenced the ozone concentrations on June 20, 2015. The difference between the observed and predicted ozone concentrations can be used to infer the amount of additional ozone created by the wildfire emissions. Using this as a metric, the wildfire is estimated to have contributed additional ozone concentrations of between 0.008 ppm to 0.013 ppm on June 20, 2015. These results provide evidence to support the assertion that the exceedances on June 20, 2015 would not have occurred “but for” the additional ozone and ozone precursor emissions created by the Lake Fire.

The robustness of this result can also be investigated by comparing the differences between all of the observed ozone concentrations and all of the predicted ozone concentrations in the regression analyses datasets. This provides a method to evaluate how much of a departure the exceeding (observed) concentrations are as compared to the expected (predicted) concentrations (i.e., statistically identifying how rare the observed concentrations are). The positive difference (when the model predicts a concentration that is less than the observed concentration) between the observed and predicted ozone concentration on June 20, 2015 can be compared to all of the recorded positive differences in the regression analysis data set (2010-2015) by assigning a percentile rank to the June 20, 2015 positive difference. Since we are not interested in those days when the model predicts a concentration that is higher than the observed concentration, days with negative differences are not included in the percentile rankings.

The percentile rank of the positive difference between the observed and predicted ozone concentrations for each of the exceeding six monitors on June 20, 2015 range from the 83rd to the 92nd percentile. This means that on average, the regression analysis indicates there is only a 8 to 17 percent chance that the positive difference between the observed and predicted ozone concentrations recorded at the six exceeding monitors would be produced under the meteorological conditions that existed on June 20, 2015. Table D–7 contains the observed and predicted ozone concentrations for June 20, 2015, the difference between the observed and the predicted concentrations, and the percentile ranking of the difference for each of the exceeding monitors.

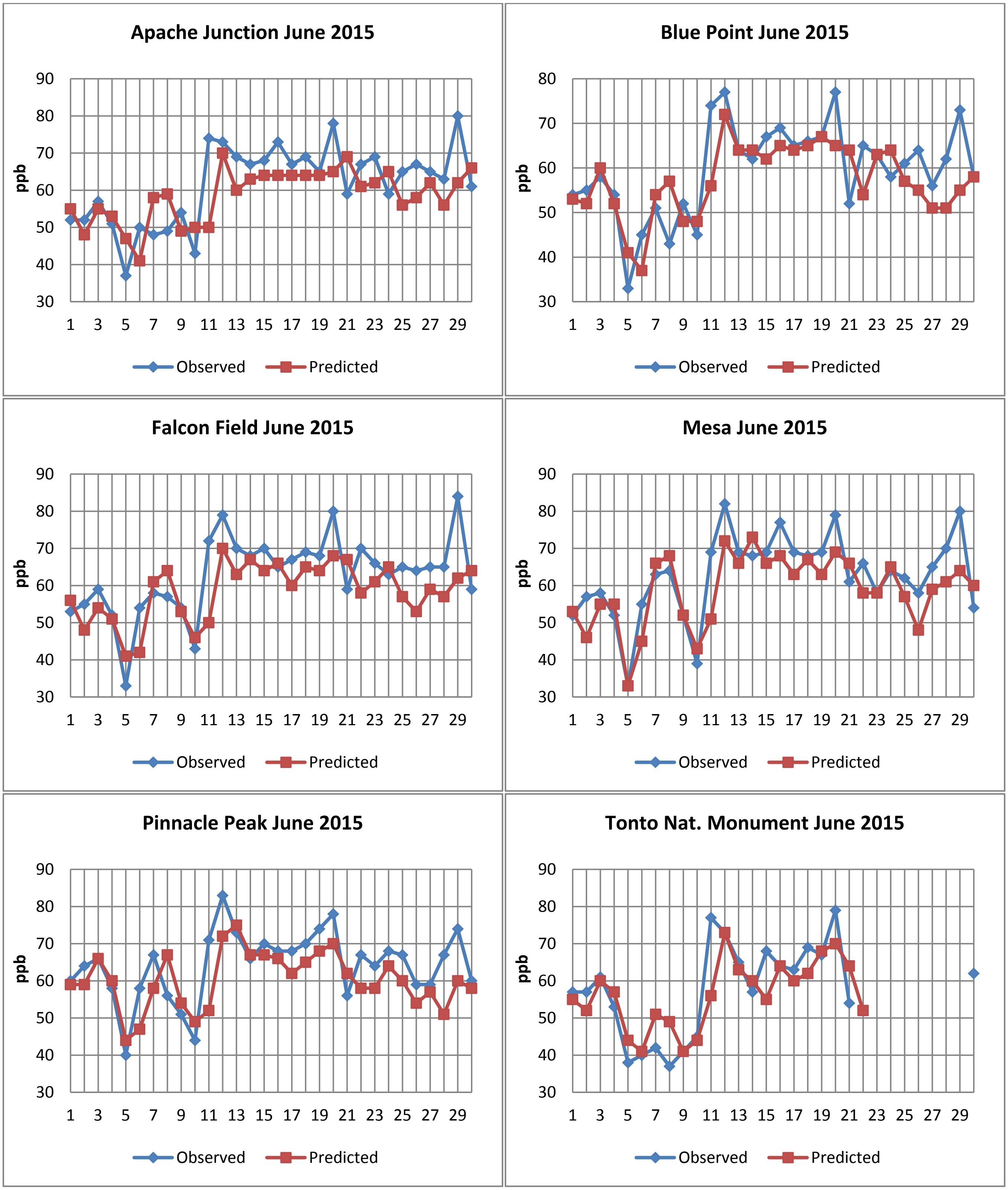


Figure D–5. Observed and predicted ozone concentrations at the six exceeding monitoring sites in June 2015.

Table D-7. Regression Analysis Results.

Monitor	Observed Ozone Concentration on June 20, 2015	Predicted Ozone Concentration on June 20, 2015	Difference Between Observed and Predicted Ozone Concentrations	Percentile Rank of Difference
Apache Junction	0.078 ppm	0.065 ppm	0.013 ppm	92nd
Blue Point	0.077 ppm	0.065 ppm	0.012 ppm	91st
Falcon Field	0.080 ppm	0.068 ppm	0.012 ppm	89th
Mesa	0.079 ppm	0.069 ppm	0.010 ppm	84th
Pinnacle Peak	0.078 ppm	0.070 ppm	0.008 ppm	83rd
Tonto Nat. Monument	0.079 ppm	0.070 ppm	0.009 ppm	84th

The Wildfire Guidance recommends employing an additional step to estimate the ozone contribution from the wildfire when comparing the difference between the observed and predicted ozone concentrations. The Guidance states that the 95th percentile of the positive differences should be identified and then added to the predicted concentration. If the sum of the predicted concentration and the 95th percentile positive difference is still less than the observed concentration, the Guidance suggests that the difference between the observed concentration and the sum of the predicted concentration and the 95th percentile difference would be an estimate of the wildfire impact (e.g., If the predicted ozone concentration for a wildfire event day is 60 ppb and the 95th percentile positive difference is 18 ppb, then the sum of these values is 78 ppb. If the observed ozone concentration on the wildfire event day was 83 ppb, then 5 ppb (83-78) can be attributed to the wildfire). Put another way, the positive difference between the observed and predicted ozone concentration on the wildfire event day(s) would have to be greater than the 95th percentile positive difference for there to be any assumed impact on ozone concentrations from the wildfire under the Wildfire Guidance methodology. Essentially this method is designed to identify statistical outliers.

As seen in Table D–7, none of the positive differences exceed the 95th percentile value for the June 20, 2015 wildfire event day. Under the Wildfire Guidance, there would be no assumed impact on ozone concentrations on June 20, 2015 from the wildfire. However, there are several important issues with this methodology that need to be explored. First, the 95th percentile of the positive differences is a very high, conservative and rare value to compare against. Because the regression models both under predict and over predict ozone concentrations in relation to observed concentrations, the 95th percentile of positive differences is also the 97th or 98th percentile of all the recorded differences (positive and negative). As such, a positive difference above the 95th percentile for the period of June 2010-2015 on which the regression analysis is based occurs only five times at the Apache Junction, Blue Point and Tonto monitors; occurs only four times at the Pinnacle Peak and Falcon Field monitors; and occurs only three times at the Mesa monitor.

Second, the days when the 95th percentile positive difference is surpassed in the June 2010-2015 period include both non-exceedance days and non-event exceedance days. In general these large positive differences are the result of two main factors: (1) since non-event exceedance days are relatively rare to begin with, the days with the highest ozone concentrations are already statistical outliers, making these days the most likely candidates to have the largest positive differences; and (2) on the non-exceedance days, the days have either a non-standard response to meteorological variables (i.e., high ozone on high wind days) or the prior day ozone concentration was significantly lower than the observed value (usually 20-30 ppb lower), making the jump to a significantly higher ozone concentration unexpected and non-normal.

Lastly, while the regression analysis can help to identify days that are non-normal, there are inherent limits to a regression analysis for ozone production, given the vast complexities involved in the production of ozone that cannot be simply captured by meteorological variables. As shown in Table D–5, the regression analysis models are able to explain about 50% of the correlation between predicted and observed concentrations, which is typical of the results seen in other regression analysis studies. That leaves 50% of the correlation as an unknown, likely explained by a combination of emissions and meteorological variables not already included in the models. These limitations are highlighted in a study performed by Sonoma Technology Incorporated (STI)[3], where the methodology suggested by the Wildfire Guidance was used to analyze ozone concentrations on days in Los Angeles (2007–2011) that may have been affected by wildfires. Despite the study identifying a large number of days (27) that were impacted by smoke from wildfires using NOAA smoke maps and satellite imagery, none of these days had positive differences above the 95th percentile, therefore finding that the identified wildfires had no impact on ozone concentrations under the Wildfire Guidance methodology. While the STI study points out that the regression models used in the study may need to be modified to perform better, the results of the STI study do call into question the validity of using a 95th percentile threshold for identifying wildfire impacts given the intrinsic performance ceiling of the regression analysis models.

With the limitations of regression analysis and the strict standard set by a 95th percentile bar, it is not surprising that none of the monitors on June 20, 2015 exceeded the 95th percentile of positive differences. While not exceeding the 95th percentile, the positive differences shown in Table D–7 (83rd-92nd percentiles) are significant and do lend substantial weight to the assumption that the concentrations seen on June 20, 2015 would not have normally occurred but for the influence of an unaccounted for variable. Given the totality of the other evidence presented in this documentation that smoke, ozone and ozone emissions from the Lake Fire did impact ozone concentrations on June 20, 2015, it is reasonable to conclude that the “unaccounted for variable” that contributed to the exceedances was the Lake Fire emissions. The regression analysis results are therefore another piece of evidence, when viewed in context of the whole body of evidence, which points to the significant contribution of the Lake Fire emissions to the ozone concentrations at the exceeding monitors in the Maricopa nonattainment area on June 20, 2015.

[3] STI, 2014. Documentation of Data Portal and Case Study to Support Analysis of Fire Impacts on Groud-Level Ozone Concentrations. Technical Memorandum prepared for the U.S. Environmental Protection Agency. STI-910507-6062.

APPENDIX E

NOTICE OF PUBLIC COMMENT PERIOD

ADEQ Arizona Department of Environmental Quality

PUBLIC NOTICE

Request for Public Comments on Exceptional Events in the Maricopa County (Greater Phoenix) O_3 Nonattainment Area

In 2005, Congress identified a need to account for events that result in exceedances of the National Ambient Air Quality Standards (NAAQS) that are exceptional in nature (e.g., not expected to reoccur or caused by acts of nature beyond man-made controls.) In response, EPA promulgated the Exceptional Events Rule (EER) to address exceptional events in 40 CFR Parts 50 and 51 on March 22, 2007 (72 FR 13560). On November 20, 2015, EPA released guidance on the preparation of exceptional events demonstrations for wildfire events that may influence ozone concentrations to State, tribal and local air agencies for review. The EER allows for states and tribes to "flag" air quality monitoring data as an exceptional event. If flagged, these data can be excluded from consideration in air quality planning if EPA concurs with the demonstration submitted by the flagging agency documenting that all procedural and technical requirements have been met.

Pursuant to 40 CFR 50.14(c)(3)(i), the Arizona Department of Environmental Quality (ADEQ) is soliciting comments on its final demonstration of an event that has caused elevated concentrations of Ozone (O_3) in the Maricopa County (Greater Phoenix) O_3 Nonattainment area on June 20, 2015. ADEQ has decided to flag exceedance concentrations based on this analysis. A copy of the demonstration is available for review beginning Thursday, August 18, 2016, on the ADEQ website at http://azdeq.gov/PN/o3_NAA. Interested parties can submit written comments throughout the comment period which will end at 5:00 p.m. on Friday, September 16, 2016. Any comments received will be responded to and forwarded to EPA with the final demonstration.

Written comments should be addressed or e-mailed to:
Air Assessment Section, Arizona Department of Environmental Quality, 1110 W. Washington Street, 3415-A, Phoenix, AZ 85007, E-mail: exceptionalevents@azdeq.gov.

In addition to being available on-line, a copy of the analysis is available for review, Monday through Friday, 8:30 a.m. to 4:30 p.m., at the ADEQ Records Management Center, 1110 W. Washington St., Phoenix, AZ, 85007, Attn: Records Center, (602) 771-4380, e-mail: recordscenter@azdeq.gov.

To request an auxiliary aid or service for accessible communication, please contact (602) 771-2215 or at co2@azdeq.gov or dial 7-1-1 for TTY/TTD Services.

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Customer Address	**Payor Address**
1110 W WASHINGTON,Attn: Jessica Bank Phoenix AZ 85007 USA	1110 W WASHINGTON,Attn: Jessica Ba Phoenix AZ 85007 USA
Customer Phone	**Payor Phone**
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Production Notes

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C-Classified:: 8/18/2016 IN2005CONGRESSIDENTIFIEDANEEDTOAC In 2005, Congress identified a need to account	Legals	1	$910.86

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In 2005, Congress identified a need to account for events that result in exceedances of the National Ambient Air Quality Standards (NAAQS) that are exceptional in nature (e.g., not expected to reoccur or caused by acts of nature beyond man-made controls.) In response, EPA promulgated the Exceptional Events Rule (EER) to address exceptional events in 40 CFR Parts 50 and 51 on March 22, 2007 (72 FR 13560). On November 20, 2015, EPA released guidance on the preparation of exceptional events demonstrations for wildfire events that may influence ozone concentrations to State, tribal and local air agencies for review. The EER allows for states and tribes to "flag" air quality monitoring data as an exceptional event. If flagged, these data can be excluded from consideration in air quality planning if EPA concurs with the demonstration submitted by the flagging agency documenting that all procedural and technical requirements have been met.

Pursuant to 40 CFR 50.14(c)(3)(i), the Arizona Department of Environmental Quality (ADEQ) is soliciting comments on its final demonstration of an event that has caused elevated concentrations of Ozone (OR3R) in the Maricopa County (Greater Phoenix) OR3 RNonattainment area on June 20, 2015. ADEQ has decided to flag exceedance concentrations based on this analysis. A copy of the demonstration is available for review beginning UThursdayU, UAugust 18, 2016U, on the ADEQ website at 26TUhttp://azdeq.gov/PN /o3_NAAU26T. Interested parties can submit written comments throughout the comment period which will end at 5:00 p.m. on Friday, September 16, 2016. Any comments received will be responded to and forwarded to EPA with the final demonstration.

Written comments should be addressed or e-mailed to:

Air Assessment Section, Arizona Department of Environmental Quality, 1110 W. Washington Street, 3415-A, Phoenix, AZ 85007, E-mail: 26Texceptionalevents@azdeq.gov26T.

In addition to being available on-line, a copy of the analysis is available for review, Monday through Friday, 8:30 a.m. to 4:30 p.m., at the 26TADEQ Records Management Center26T, 1110 W. Washington St., Phoenix, AZ, 85007, Attn: Records Center, (602) 771-4380, e-mail: recordscenter @azdeq.gov.

To request an auxiliary aid or service for accessible communication, please contact (602) 771-2215 or at 26T co2@azdeq.gov26T or dial 7-1-1 for TTY/TTD Services.

Pub. Aug. 18, 2016

APPENDIX F

EXCEPTIONAL EVENT INITIAL NOTIFICATION FORM

EE Initial Notification Summary Information for June 20, 2015 Ozone in Maricopa County

Submitting Agency: **Arizona Department of Environmental Quality**
Agency Contact: **Brad Busby (602) 771-7676 or Jonny Malloy (602) 771-6815**
Date Submitted: **July 8, 2016**
Applicable NAAQS: **0.075 ppm (73 FR 16483 Mar 27, 2008) & 0.070 ppm (80 FR 65292 Oct 26, 2015)**
Affected Regulatory Decision[1]: **Attainment Determination (2008) and Designation (2015)**
(for classification decisions, specify level of the classification with/without EE concurrence)
Area Name/Designation Status: **Maricopa County Ozone Nonattainment Area / Moderate Nonattainment**
Design Value Period (list three year period): **2014-2016 (preliminary through July 7, 2016)**

A) Information specific to each flagged site day that may be submitted to EPA in support of the affected regulatory decision listed above

Date of Event	Type of Event	AQS Flag	Site AQS ID	Site Name	Exceedance Concentration	Notes (e.g. event name, links to other events)
6/20/15	Wildfire	RT	04-021-3001	Apache Junction	0.078 ppm	Linked to smoke/precursor transport from the Lake Fire in SE California
6/20/15	Wildfire	RT	04-013-9702	Blue Point	0.077 ppm	Linked to smoke/precursor transport from the Lake Fire in SE California
6/20/15	Wildfire	RT	04-013-1010	Falcon Field	0.080 ppm	Linked to smoke/precursor transport from the Lake Fire in SE California
6/20/15	Wildfire	RT	04-013-1003	Mesa	0.079 ppm	Linked to smoke/precursor transport from the Lake Fire in SE California
6/20/15	Wildfire	RT	04-013-2005	Pinnacle Peak	0.078 ppm	Linked to smoke/precursor transport from the Lake Fire in SE California
6/20/15	Wildfire	RT	04-007-0010	Tonto NM	0.079 ppm	Linked to smoke/precursor transport from the Lake Fire in SE California

B) Violating Sites Information

Site/monitor (AQS ID and POC)	Design Value (without EPA concurrence on any of the events listed in table A above)	Design Value (with EPA concurrence on all events listed in table A above)
Mesa / 04-013-1003	0.076	0.074
Pinnacle Peak / 04-013-2005	0.076	0.075
Tonto National Monument / 04-007-0010	0.071	0.070

Notes:
1. All monitors in the Maricopa nonattainment area currently meet the 2008 ozone standard (0.075) using preliminary 2014-2016 values when the June 20, 2015 wildfire event is excluded as of July 7, 2016.
2. The Tonto National Monument monitor in rural Gila County, Arizona is currently not a part of an ozone nonattainment area. Exclusion of the June 20, 2015 ozone wildfire exceptional event is necessary to ensure that the area around the Tonto monitor is not needlessly included in a future nonattainment area for the 2015 ozone standard.
3. The final rule promulgating the 2015 ozone standard requires that for exceptional events which occurred in 2015 and affect initial area designations for the 2015 standard, documentation of these events must be submitted to EPA by October 1, 2016 (see Table 6 at 80 FR 65415). As such, even though the design value for the 2014-2016 period will still be preliminary for the Tonto National Monument monitor on October 1, 2016, the EPA rule requires that documentation for the June 20, 2015 ozone wildfire exceptional event be submitted by October 1, 2016.

[1] designation, classification, attainment determination, attainment date extension, or finding of SIP inadequacy leading to SIP call
[2] Provide additional information for types of event described as "other"

C) Summary of Maximum Design Value (DV) Site Information (Effect of EPA Concurrence on Maximum Design Value Site Determination)

In reference to the 2008 ozone standard for the Maricopa 2008 eight-hour ozone nonattainment area:

Maximum DV site (AQS ID) **without EPA concurrence** on any of the events listed in table A above	Design Value **0.076**	Design Value Site **Pinnacle Peak - 04-013-2005**	Comment
Maximum DV site (AQS ID) **with EPA concurrence** on all events listed in table A above	Design Value **0.075**	Design Value Site **Pinnacle Peak - 04-013-2005**	Comment

In reference to the 2015 ozone standard for the Gila County Tonto National Monument monitor currently located outside of the Maricopa nonattainment area:

Maximum DV site (AQS ID) **without EPA concurrence** on any of the events listed in table A above	Design Value **0.071**	Design Value Site **Tonto National Monument - 04-007-0010**	Comment
Maximum DV site (AQS ID) **with EPA concurrence** on all events listed in table A above	Design Value **0.070**	Design Value Site **Tonto National Monument - 04-007-0010**	Comment

D) List of any sites (AQS ID) within planning area with invalid design values (e.g., due to data incompleteness)

N/A

APPENDIX G

SUPPLEMENTARY ANALYSIS OF THE EXCEEDANCE AT THE TONTO NATIONAL MONUMENT MONITOR IN RELATION TO THE 2015 OZONE STANDARD

Introduction

The weight of evidence presented in this report is primarily included to demonstrate that transport of ozone and ozone precursor emissions from the Lake Fire in southeastern California caused exceedances of the 2008 ozone standard (0.075 ppm) on June 20, 2015 at six monitors in or very near the Maricopa nonattainment area. The exclusion of the June 20, 2015 exceedances as an exceptional event is necessary for the Maricopa nonattainment area to attain the 2008 ozone standard in 2016 (using data from the 2014-2016 ozone seasons).

Exclusion of the June 20, 2015 exceedances as an ozone wildfire exceptional event by the EPA prevents the exceedance data from being used in calculation of the ozone design value. Since the data is completely excluded from use once an exceptional event is approved (i.e., no substitute eight-hour ozone concentrations are created for the exceptional event exceedances), the data by default is excluded from use in calculation of the ozone design value for both the 2008 and 2015 eight-hour ozone standards (0.075 and 0.070 ppm, respectively).

Because exclusion of the June 20, 2015 data as an exceptional event exceedance of the 2008 standard will have the practical effect of excluding the data for use in calculation of the ozone design value for the 2015 ozone standard, EPA Region IX has asked for additional analysis of the June 20, 2015 exceedance at the Tonto National Monument monitor in relation to the 2015 ozone standard of 0.070 ppm. The Tonto National Monument monitor currently meets the 2008 ozone standard, but does not meet the 2015 ozone standard with a design value calculated using 2013-2015 ozone season data. If the June 20, 2015 exceedance at the Tonto monitor is excluded as an exceptional event, it is possible that the Tonto monitor may meet the 2015 ozone standard using data from the 2015 ozone season (i.e., the design value based upon 2015-2017 data). As the Tonto monitor is currently not included in an ozone nonattainment area, exclusion of the June 20, 2015 exceedance as an exceptional event is regulatory significant for the Tonto monitor, as it may prevent the area from unnecessarily being designated by the EPA as part of a nonattainment area for the 2015 ozone standard.

The additional analysis presented in this Appendix concludes that the June 20, 2015 exceedance of the ozone standard at the Tonto National Monument monitor would qualify as an exceptional event for both the 2008 and 2015 ozone standards. The data and analysis presented below, in conjunction with the data and analysis already presented in the other sections of this report, show that without the influence of the Lake Fire, the Tonto National Monument monitor would not have exceeded either the 2008 or the 2015 ozone standard (i.e., the eight-hour ozone concentration would have been 0.070 ppm or less).

Ozone Trend Data at the Tonto National Monument Monitor

The Tonto National Monument monitor is operated by the Arizona Department of Environmental Quality and is located in the middle of the Tonto National Forest in Gila County, Arizona. Since beginning operation in 2002, the ozone concentrations at the Tonto National Monument monitor have shown a steady downward trend. Figure G–1 displays the annual number of days the Tonto monitor has exceeded 0.070 ppm, and the annual fourth high eight-hour ozone concentration for years 2002-2016 (data for 2016 is preliminary through August 9, 2016). Both statistics show substantial decreases over time, and indicate that exceedances of the 2015 ozone standard are becoming rarer with each passing year, particularly in the last three-year period of 2014-2016. The rarity of recent exceedances as seen in Figure G–1 lends additional weight of evidence to the conclusion that the concentration seen on June 20, 2015 (0.079 ppm) was not normal or expected.

Trend data during the days before and after the event also show that a concentration over 0.070 ppm was unexpected at the Tonto Monitor, as no other days during this time period recorded actual eight-hour concentrations higher than 0.069 ppm (see note in Table G–1). As pointed out in the main document, June 20, 2015 is a Saturday, a day when average ozone-forming anthropogenic emissions are lower than the weekdays, making it less likely that a spike in anthropogenic emissions contributed to the exceedance on June 20, 2015. There are no significant anthropogenic sources of ozone precursors near the Tonto monitor, as the Tonto monitor is located in the middle of the Tonto National Forest and is primarily influenced by background ozone concentrations. Table G–1 displays the maximum daily eight-hour ozone concentrations before and after the June 20, 2015 exceedance at the Tonto National Monument monitor.

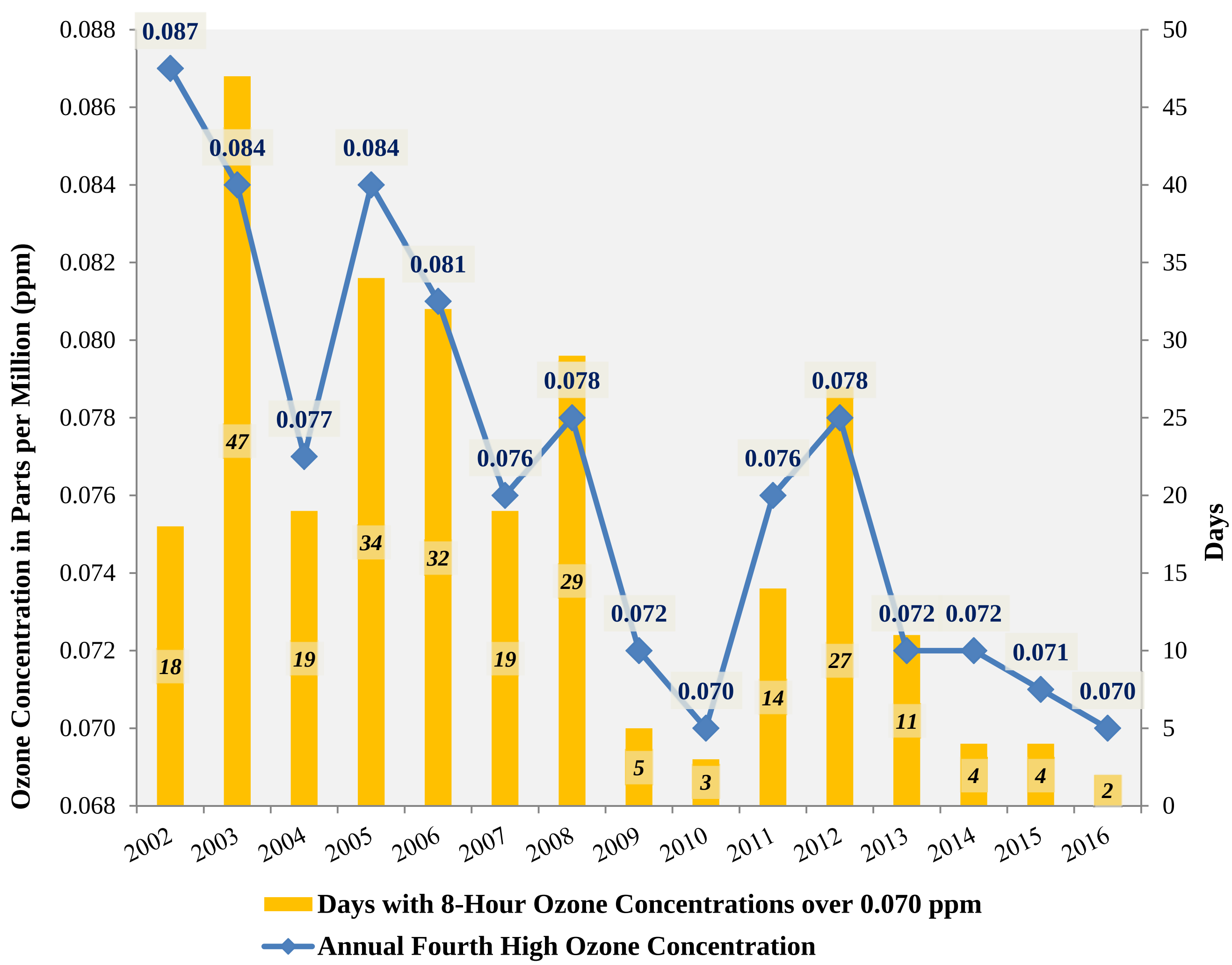


Figure Notes: (1) The exceptional event exceedance on June 20, 2015 has been excluded from the trend data. (2) The fourth high of 0.071 ppm in 2015 is the result of monitor failure on June 22, 2015 which allowed a 6-hour period to count as an 8-hour concentration. Had the Tonto monitor been functioning properly on June 22, 2015, the monitor would not have exceeded and the resulting fourth high for 2015 would have been 0.070 ppm.

Figure G–1. Downward trends in ozone concentrations at the Tonto National Monument monitor.

Table G–1. Maximum Daily Eight-Hour Ozone Concentrations (ppm) at the Tonto National Monument Monitor on June 13-27, 2015, as Compared to the 2015 Ozone Standard.

June 13	June 14	June 15	June 16	June 17	June 18	June 19	June 20	June 21	June 22	June 23	June 24	June 25	June 26	June 27
0.065	0.057	0.068	0.064	0.063	0.069	0.067	**0.079**	0.054	0.071*	N/A	N/A	N/A	N/A	N/A

**Note: According to the Arizona Department of Environmental Quality, the Tonto monitor stopped working at approximately 9 pm on June 22, 2015 due to an airflow pump failure. Because of this failure, a consecutive 6-hour period of hourly ozone concentration data is used in place of an actual 8-hour average under the technical calculations of Appendix U to 40 CFR Part 50. The hourly ozone concentrations were coming down when the monitor failure occurred. Had the monitor operated for the full day, the monitor would not have exceeded the 2015 ozone standard on June 22, 2015, even assuming ozone concentrations did not decline further (worst case conditions) from the last recorded hourly value on June 22, 2015. The highest actual 8-hour average concentration (i.e., a full consecutive eight hours) recorded on June 22, 2015 was 0.065 ppm.*

Additional HYSPLIT Analyses

Back trajectories were computed for the Tonto National Monument monitor at heights of 100 and 1500 meters above ground level. The back trajectories start at the hour with the highest ozone concentration at the Tonto monitor. 24-hour back trajectories were completed for June 18-21, 2015, and overlaid on smoke maps from NOAA, showing the approximate dispersion of smoke from the Lake Fire. The back trajectories cross over or very near the smoke from the Lake Fire primarily on June 19-20, 2015. This suggests that the ozone concentrations at the Tonto monitor were affected by the smoke, ozone and ozone precursor emissions from the Lake Fire on June 19-20, 2015, culminating with an exceedance of the 2008 and 2015 ozone standards on June 20, 2015. The back trajectories are shown in Figures G–2 through G–5 below. The back trajectory outputs from the HYSPLIT model are included at the end of this Appendix.

The back trajectories in Figures G–2 through G–5 are overlaid on smoke maps from the prior day, instead of the same day, as there is often a delay between the dispersion of smoke and emissions from a wildfire and corresponding impacts to ground-level ozone. As an example, it can take time for the fire emissions in the upper air to mix with the lower air and impact ground-level ozone monitors. Also, if the fire emissions occurred primarily at night, they would need the following day's sunlight before ozone from the fire emissions would form. Lastly, this display in the figures allows the endpoint of the back trajectory to match up with the time period of the smoke maps, allowing for a visualization of the approximate area of the air parcel that eventually impacted the Tonto monitor 24-hours later.

As discussed in the main body of the report, nearly all of western and northern Arizona had ozone concentrations that were affected by the Lake Fire during June 18-20, 2015. While Figures G–2 through G–5 show the back trajectories in relation to smoke dispersion, the invisible ozone formed in western Arizona on June 18 and June 19, 2015 in response to the Lake Fire emissions was also transported to the Tonto monitor, causing the exceedance on June 20, 2015.

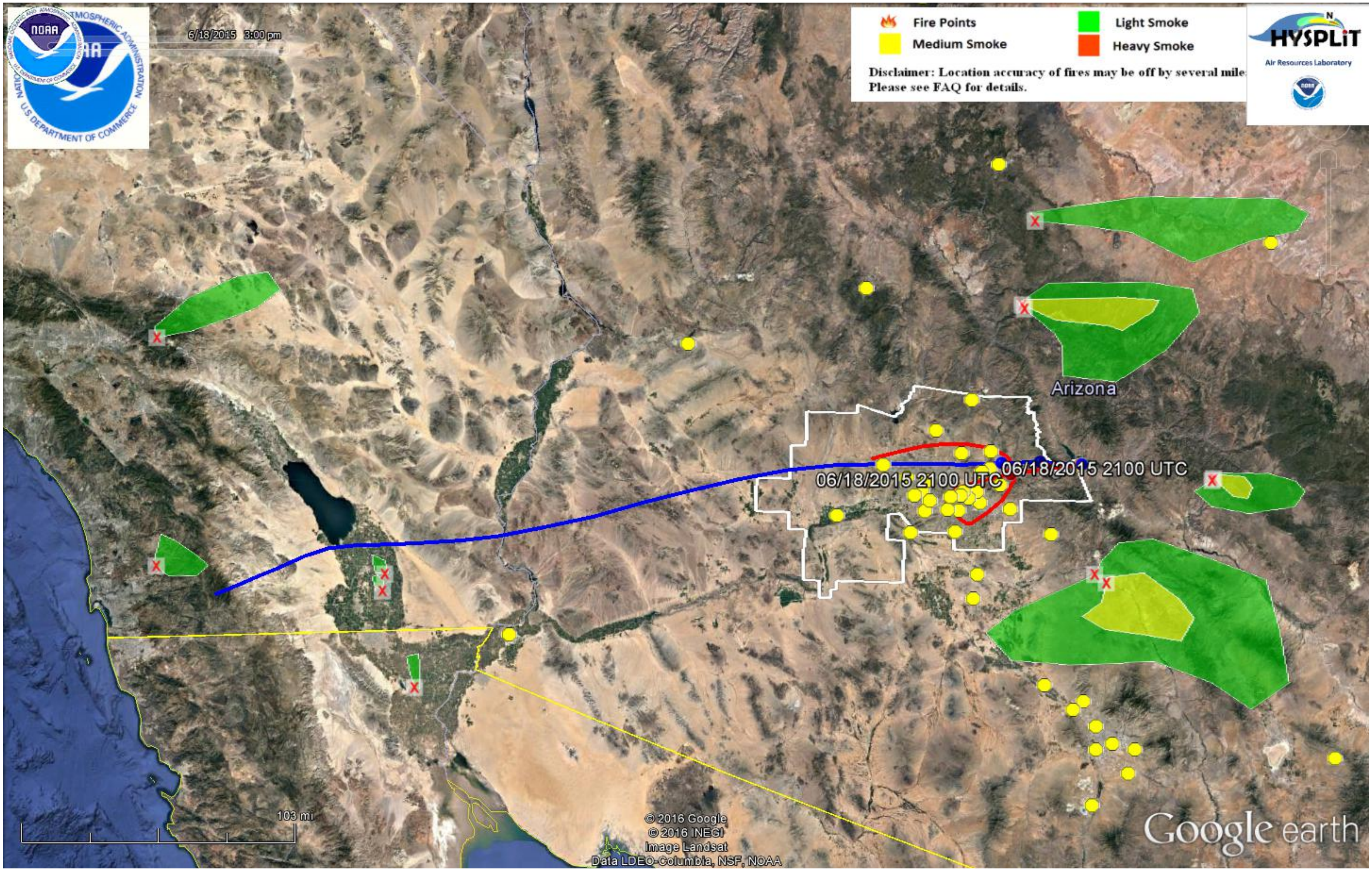


Figure G–2. June 18, 2015 back trajectory from the Tonto National Monument monitor at 100 (red) and 1500 (blue) meters overlaid on smoke dispersion map from June 17, 2015.

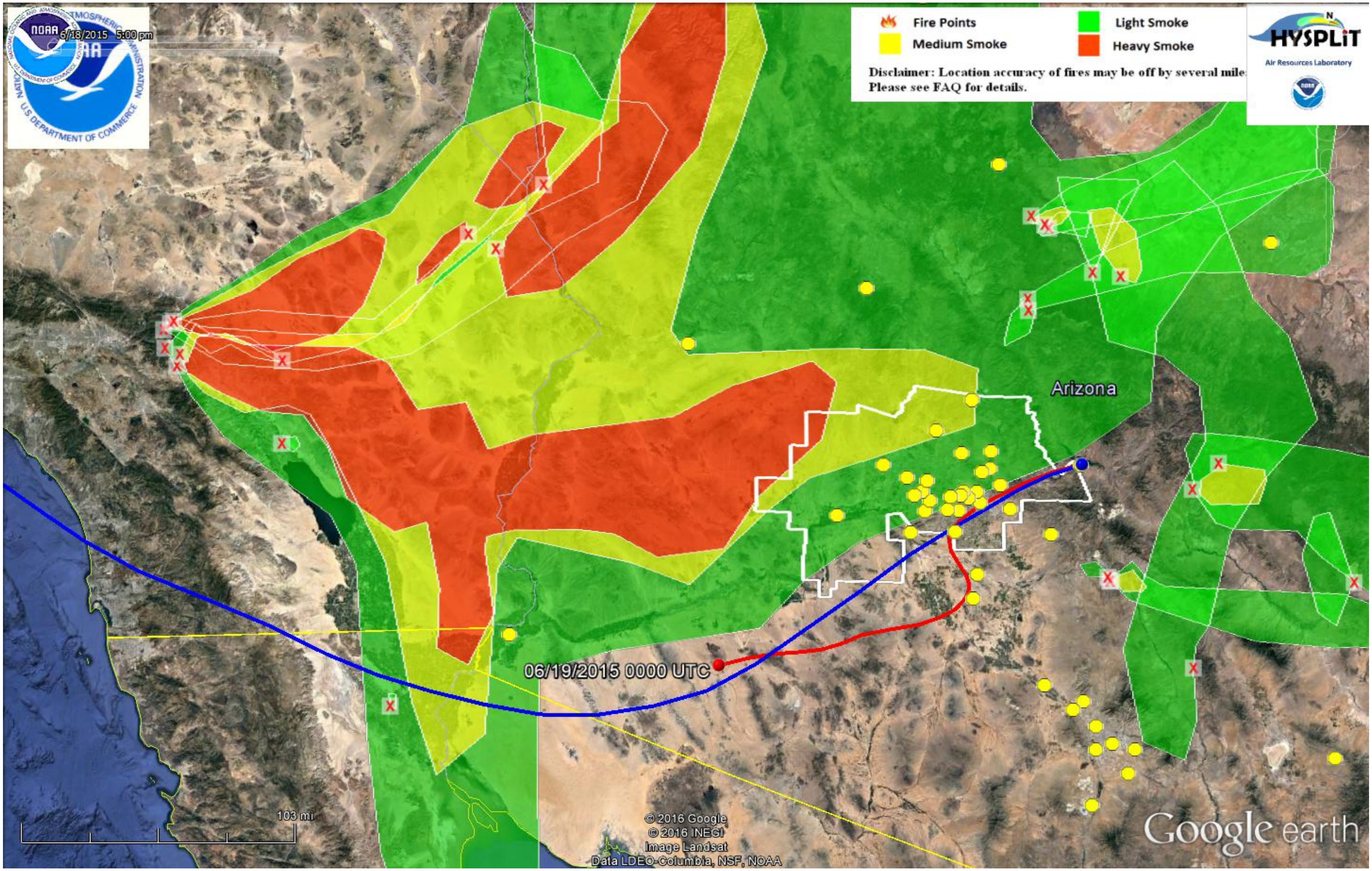


Figure G–3. June 19, 2015 back trajectory from the Tonto National Monument at 100 (red) and 1500 (blue) meters overlaid on smoke dispersion map from June 18, 2015.

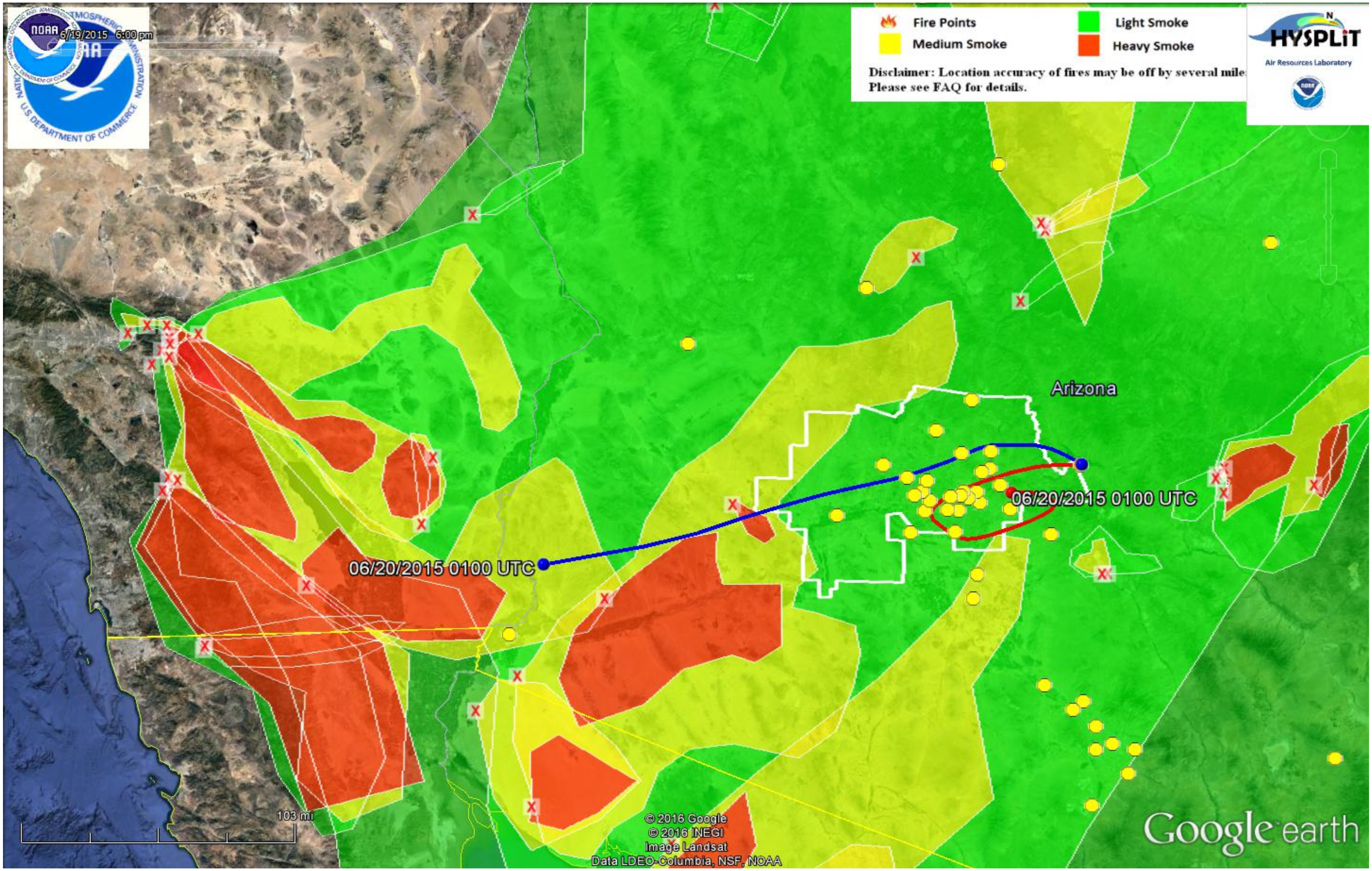


Figure G–4. June 20, 2015 back trajectory from the Tonto National Monument at 100 (red) and 1500 (blue) meters overlaid on smoke dispersion map from June 19, 2015.

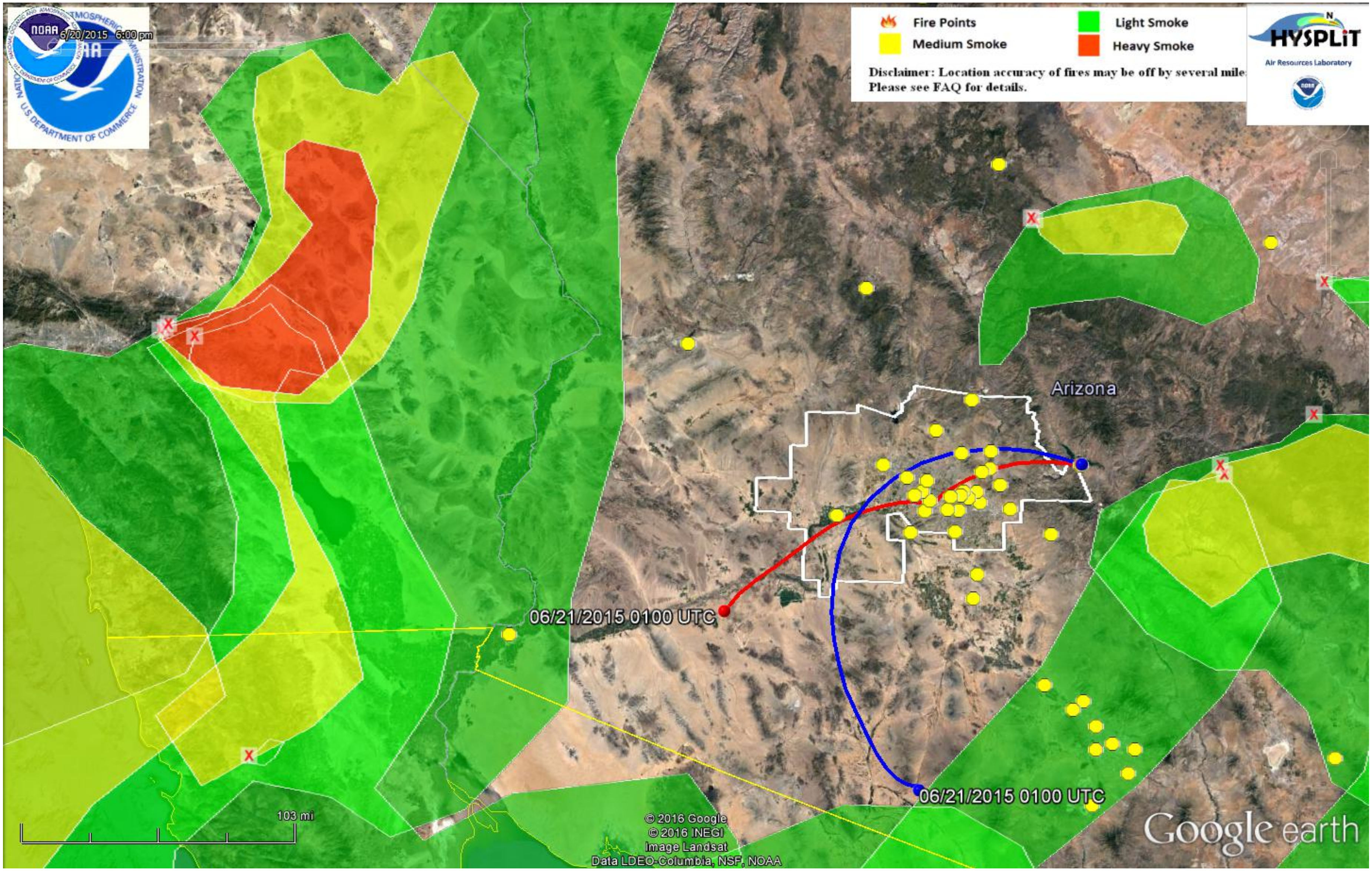


Figure G–5. June 21, 2015 back trajectory from the Tonto National Monument at 100 (red) and 1500 (blue) meters overlaid on smoke dispersion map from June 20, 2015.

Additional Regression Analysis Examination

Appendix D of this report provides a detailed explanation of the multi-variable regression analysis which was used to estimate and quantify the impact the Lake Fire had on June 20, 2015 ozone concentrations. That analysis estimated that without the transported ozone and ozone precursor emissions from the Lake Fire, the average ozone concentration at the Tonto National Monument monitor under the meteorological conditions that existed on June 20, 2015 would have been 0.070 ppm, instead of 0.079 ppm.

Since the predicted value of 0.070 ppm is right at the level of the 2015 ozone standard, additional regression analysis work was performed to improve the performance of the Tonto National Monument monitor regression analysis. This supplementary work provides additional evidence that the expected ozone concentration on June 20, 2015, without the impacts from the Lake Fire, would not cause an exceedance of the 2015 ozone standard.

The initial regression analysis in Appendix D utilized surface meteorology measurements from the Sky Harbor International Airport for all six exceeding monitoring sites in an effort to use quality assured and consistent meteorological data for the analysis. However, the Tonto National Monument monitor is located in a national forest, over 85 kilometers away from the Sky Harbor airport. As such, surface meteorology can vary significantly at times between the Tonto monitor and Sky Harbor airport. While there are no official National Weather Service stations located near the Tonto monitor, the Unites States Forest Service and the Bureau of Land Management operate a Remote Automated Weather Station (RAWS) near the Tonto National Monument monitor (Station #TTBA3, see http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?azATON). The RAWS station is located in the small Tonto National Forest community of Punkin Center, Arizona, approximately 30 kilometers from the Tonto National Monument monitor. Both the RAWS station and the Tonto monitor are located in the Tonto Basin with similar geography and elevation. This station has consistent, hourly recorded values of temperature, dew point, solar radiation and wind for the time period utilized in the regression analysis (the month of June for years 2010-2015). While not official NWS data, the data is maintained by government agencies and is more representative of surface meteorology at the Tonto monitor than the Sky Harbor data. Use of the local temperature, dew point, and wind data in place of Sky Harbor temperature, dew point and wind data in a re-run regression analysis improved the performance of the regression analysis (solar radiation data from the Punkin Center site had no effect on the regression analysis). The calendar year of the regression data was also found to improve the regression analysis, as this categorical variable serves as a surrogate for macro trends in the data that may change from year to year. All other regression variables remained the same as reported in Appendix D.

Using the new data and variable discussed above, the regression analysis performance improved from an adjusted R^2 value of 0.584 to a new value of 0.616. The predicted June 20, 2015 ozone concentration using the new regression analysis is 0.069 ppm. This value is 0.002 ppm below an exceedance of the 2015 ozone standard, and 0.007 ppm below an exceedance of the 2008 ozone standard. Tables G–2 and G–3 contain performance metrics for the new, re-run regression analysis.

Table G–2. Updated Regression Analysis Performance Statistics.

Monitor	Adjusted. R^2	F	Significance (p)
Tonto Nat. Monument – Model Summary	0.616	25.072	0.000

Table G–3. Coefficient, Importance, *t*-statistic, *p*-value and Standard Error for the Updated Regression Model.

Model Variables	Coefficient	Importance	*t*	*p*	Std. Error
Prior	0.435	0.361	7.892	0.000	0.055
UpDir = WSW	-6.329	0.164	-5.159	0.000	1.227
UpDir = ESE, SSW	-6.698	0.164	-3.080	0.002	2.175
UpDir = ENE, NNE, NNW, SSE, WNW	0	0.164			
TontoBasinAfternoonWindDir = WSW (new)	4.923	0.109	4.335	0.000	1.136
TontoBasinAfternoonWindDir = SSE, SSW, WNW (new)	0	0.109			
TontoBasinDewPoint (new)	-0.241	0.098	-4.116	0.000	0.059
Pressure	-32.596	0.080	-3.704	0.000	8.8
Year = 2014 (new)	-3.515	0.076	-2.545	0.012	1.381
Year = 2010, 2011 (new)	2.016	0.076	1.752	0.082	1.151
Year = 2012, 2013, 2015 (new)	0	0.076			
Day = MON, SUN	-3.206	0.054	-3.064	0.003	1.046
Day = TUES, WED, THUR, FRI, SAT	0	0.054			
TontoBasinAverageTemp (new)	-0.406	0.050	-2.940	0.004	0.138
UpTemp	0.297	0.007	1.134	0.259	0.262
Intercept	1047.151		3.948	0.000	265.226

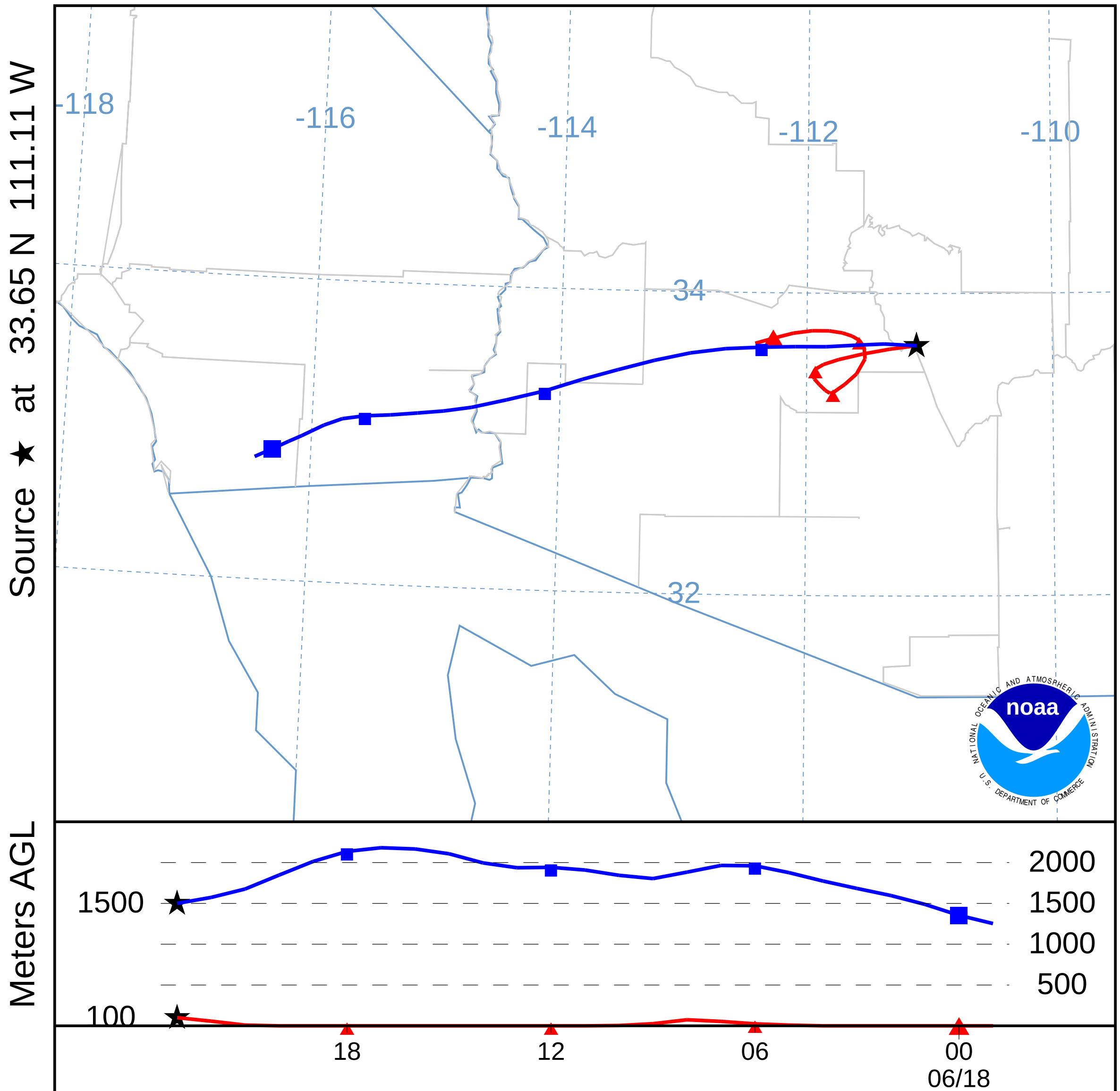
The June 20, 2015 ozone concentration prediction of 0.069 ppm in the re-run regression model provides additional evidence that the concentration of 0.079 ppm recorded on June 20, 2015 is out of the ordinary given the existing meteorological conditions on June 20, 2015. The re-run regression analysis also provides support to the initial regression analysis performed in Appendix D, as the re-run regression model produces similar results to the regression model in Appendix D, even with the improved local meteorological data.

In summary, the data presented in this Appendix provides further evidence, complimentary to and in support of evidence already presented throughout this report, that the June 20, 2015 exceedance at the Tonto National Monument monitor qualifies as an exceptional event under either the 2008 or 2015 ozone standard.

NOAA HYSPLIT MODEL

Backward trajectories ending at 2300 UTC 18 Jun 15

NAM Meteorological Data



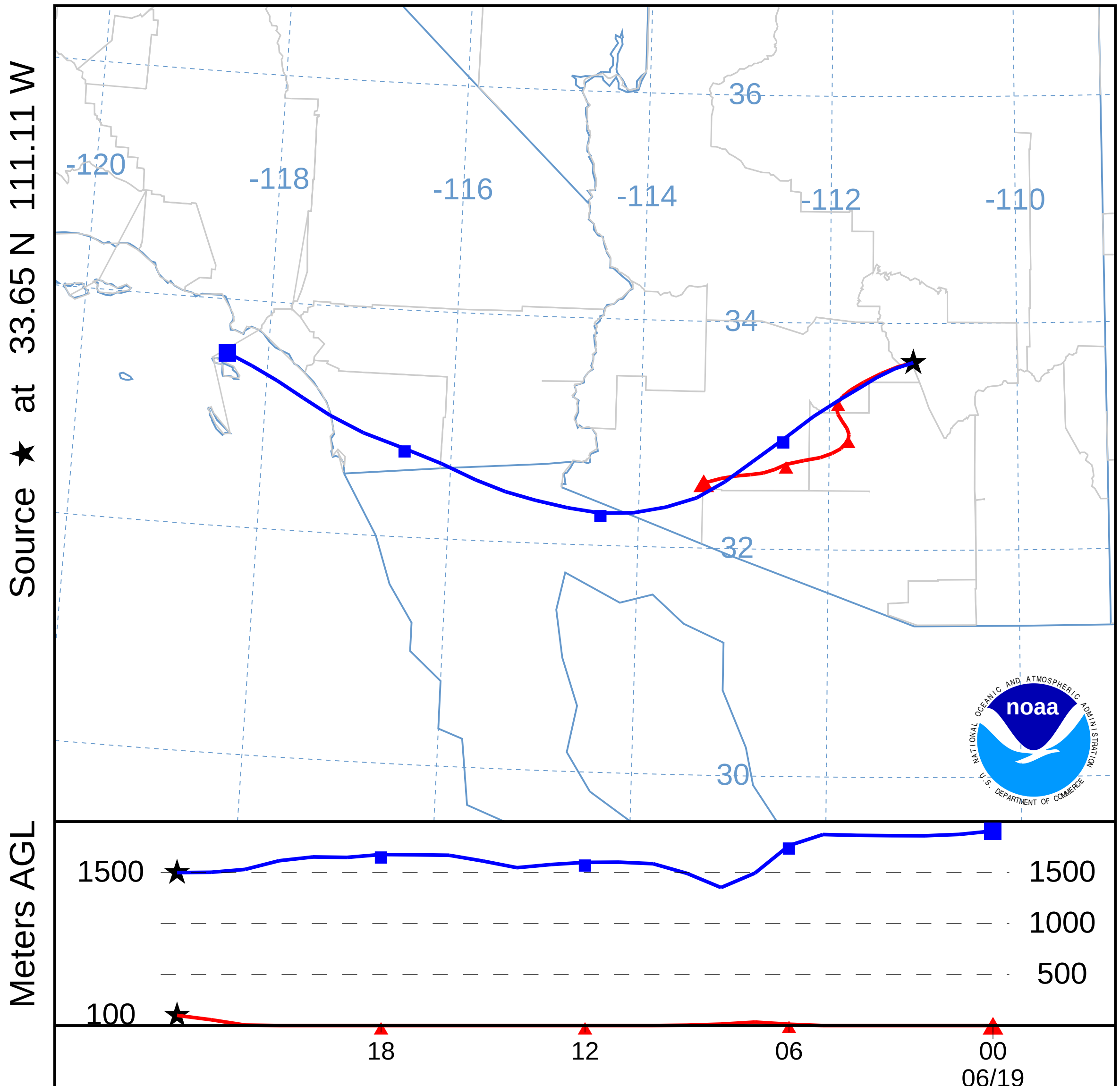
Job ID: 113204 Job Start: Thu Aug 4 21:34:24 UTC 2016
Source 1 lat.: 33.655000 lon.: -111.107000 heights: 100, 1500 m AGL

Trajectory Direction: Backward Duration: 24 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 18 Jun 2015 - NAM12

NOAA HYSPLIT MODEL

Backward trajectories ending at 0000 UTC 20 Jun 15

NAM Meteorological Data



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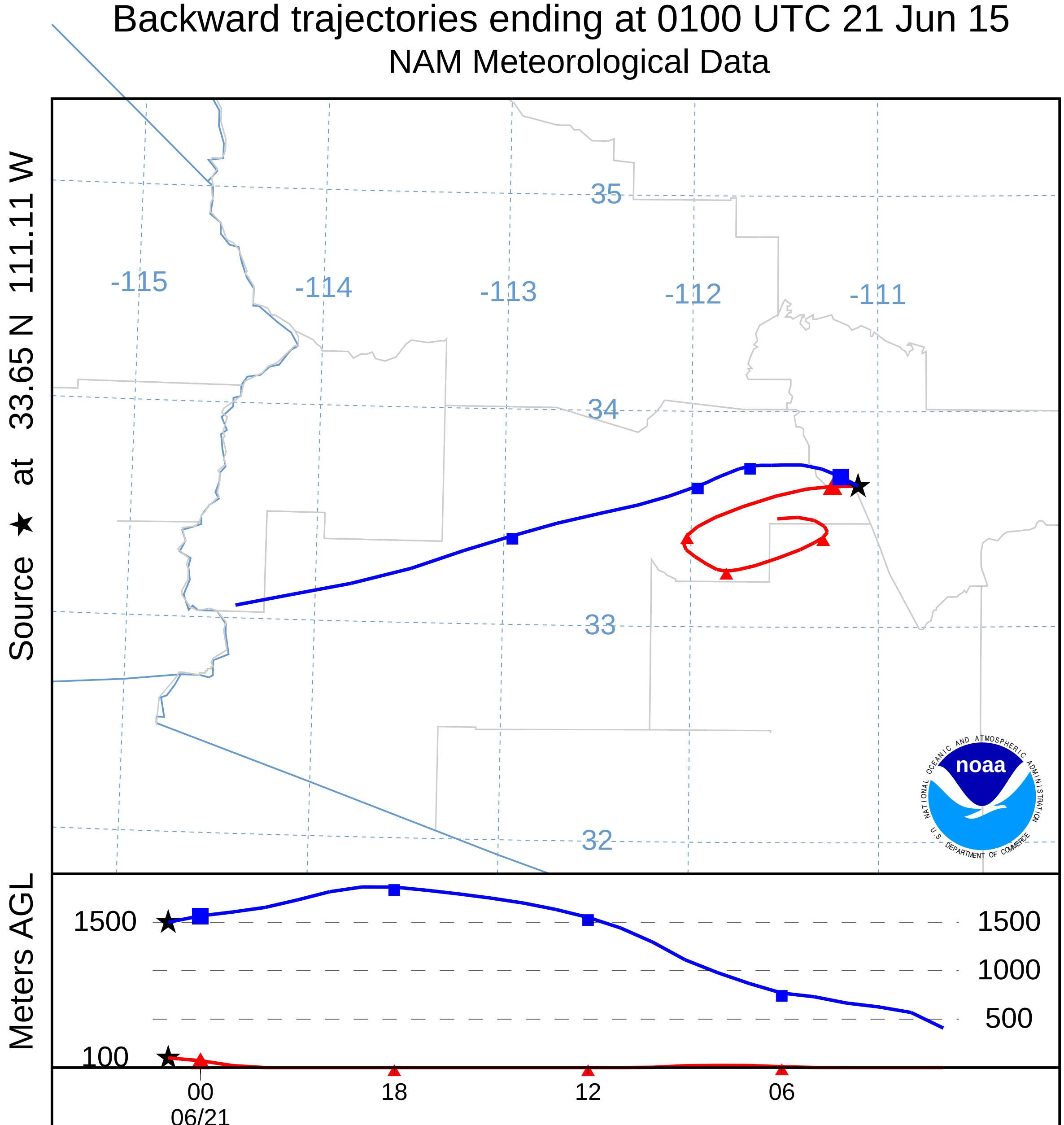
Source 1 lat.: 33.655000 lon.: -111.107000 heights: 100, 1500 m AGL

Trajectory Direction: Backward Duration: 24 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 20 Jun 2015 - NAM12

NOAA HYSPLIT MODEL

Backward trajectories ending at 0100 UTC 21 Jun 15

NAM Meteorological Data



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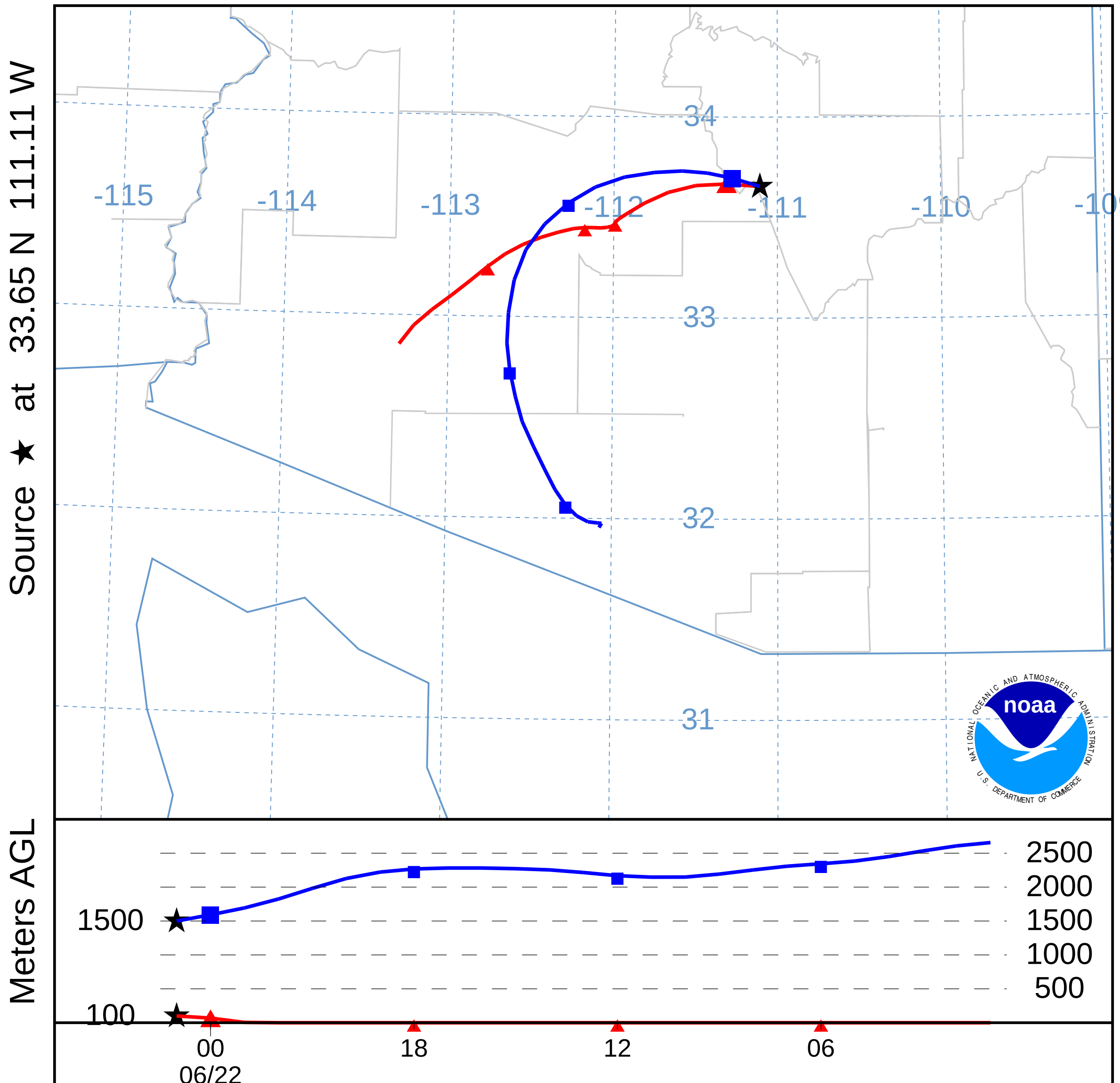
Trajectory Direction: Backward Duration: 24 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 21 Jun 2015 - NAM12

NOAA HYSPLIT MODEL
Backward trajectories ending at 0100 UTC 22 Jun 15
NAM Meteorological Data



Job ID: 112737 Job Start: Thu Aug 4 21:11:46 UTC 2016
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Trajectory Direction: Backward Duration: 24 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 22 Jun 2015 - NAM12